



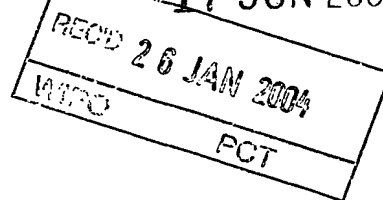
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10 / 539483  
PCT/GB 2003 / 005640

17 JUN 2005



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**Patentanmeldung Nr. Patent application No. Demande de brevet n°**

02293240.4

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Anmeldung Nr:  
Application no.: 02293240.4  
Demande no:

Anmeldetag:  
Date of filing: 24.12.02  
Date de dépôt:

Anmelder/Applicant(s)/Demandeur(s):

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151 85 Södertälje  
SUEDE

Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:  
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.  
If no title is shown please refer to the description.  
Si aucun titre n'est indiqué se référer à la description.)

Chemical compounds

In Anspruch genommene Priorität(en) / Priority(ies) claimed / Priorité(s)  
revendiquée(s)

Staat/Tag/Aktenzeichen/State/Date/File no./Pays/Date/Numéro de dépôt:

Internationale Patentklassifikation/International Patent Classification/  
Classification internationale des brevets:

C07F9/00

Am Anmeldetag benannte Vertragstaaten/Contracting states designated at date of  
filing/Etats contractants désignées lors du dépôt:

AT BE BG CH CY CZ DE DK EE ES FI FR GB GR IE IT LI LU MC NL PT SE SI SK

CHEMICAL COMPOUNDS

The present invention relates to certain quinazoline derivatives for use in the treatment of certain diseases in particular to proliferative disease such as cancer and in the preparation  
5 of medicaments for use in the treatment of proliferative disease, to novel quinazoline compounds and to processes for their preparation, as well as pharmaceutical compositions containing them as active ingredient.

Cancer (and other hyperproliferative disease) is characterised by uncontrolled cellular proliferation. This loss of the normal regulation of cell proliferation often appears to occur as  
10 the result of genetic damage to cellular pathways that control progress through the cell cycle.

In eukaryotes, an ordered cascade of protein phosphorylation is thought to control the cell cycle. Several families of protein kinases that play critical roles in this cascade have now been identified. The activity of many of these kinases is increased in human tumours when compared to normal tissue. This can occur by either increased levels of expression of the  
15 protein (as a result of gene amplification for example), or by changes in expression of co activators or inhibitory proteins.

The first identified, and most widely studied of these cell cycle regulators have been the cyclin dependent kinases (or CDKs). Activity of specific CDKs at specific times is essential for both initiation and coordinated progress through the cell cycle. For example, the  
20 CDK4 protein appears to control entry into the cell cycle (the G0-G1-S transition) by phosphorylating the retinoblastoma gene product pRb. This stimulates the release of the transcription factor E2F from pRb, which then acts to increase the transcription of genes necessary for entry into S phase. The catalytic activity of CDK4 is stimulated by binding to a partner protein, Cyclin D. One of the first demonstrations of a direct link between cancer and  
25 the cell cycle was made with the observation that the Cyclin D1 gene was amplified and cyclin D protein levels increased (and hence the activity of CDK4 increased) in many human tumours (Reviewed in Sherr, 1996, Science 274: 1672-1677; Pines, 1995, Seminars in Cancer Biology 6: 63-72). Other studies (Loda et al., 1997, Nature Medicine 3(2): 231-234; Gemma et al., 1996, International Journal of Cancer 68(5): 605-11; Elledge et al. 1996,  
30 Trends in Cell Biology 6; 388-392) have shown that negative regulators of CDK function are frequently down regulated or deleted in human tumours again leading to inappropriate activation of these kinases.

More recently, protein kinases that are structurally distinct from the CDK family have been identified which play critical roles in regulating the cell cycle and which also appear to be important in oncogenesis. These include the newly identified human homologues of the *Drosophila* aurora and *S.cerevisiae* Ipl1 proteins. The three human homologues of these  
5 genes Aurora-A, Aurora-B and Aurora-C (also known as aurora2, aurora1 and aurora3 respectively) encode cell cycle regulated serine-threonine protein kinases (summarised in Adams *et al.*, 2001, Trends in Cell Biology. 11(2): 49-54). These show a peak of expression and kinase activity through G2 and mitosis. Several observations implicate the involvement of human aurora proteins in cancer. This evidence is particularly strong for Aurora-A. The  
10 Aurora-A gene maps to chromosome 20q13, a region that is frequently amplified in human tumours including both breast and colon tumours. Aurora-A may be the major target gene of this amplicon, since Aurora-A DNA is amplified and mRNA overexpressed in greater than 50% of primary human colorectal cancers. In these tumours Aurora-A protein levels appear greatly elevated compared to adjacent normal tissue. In addition, transfection of rodent  
15 fibroblasts with human Aurora-A leads to transformation, conferring the ability to grow in soft agar and form tumours in nude mice (Bischoff *et al.*, 1998, The EMBO Journal. 17(11): 3052-3065). Other work (Zhou *et al.*, 1998, Nature Genetics. 20(2): 189-93) has shown that artificial overexpression of Aurora-A leads to an increase in centrosome number and an increase in aneuploidy, a known event in the development of cancer. Other work has shown  
20 an increase in expression of Aurora-B (Adams *et al.*, 2001, Chromsoma. 110(2):65-74) and Aurora-C (Kimura *et al.*, 1999, Journal of Biological Chemistry, 274(11): 7334-40) in tumour cells when compared to normal cells.

Importantly, it has also been demonstrated that abrogation of Aurora-A expression and function by antisense oligonucleotide treatment of human tumour cell lines (WO 97/22702  
25 and WO 99/37788) leads to cell cycle arrest and exerts an antiproliferative effect in these tumour cell lines. Additionally, small molecule inhibitors of Aurora-A and Aurora-B have been demonstrated to have an antiproliferative effect in human tumour cells (Keen *et al.* 2001, Poster #2455, American Association of Cancer research annual meeting). This indicates that inhibition of the function of Aurora-A (and possibly Aurora-B) will have an antiproliferative  
30 effect that may be useful in the treatment of human tumours and other hyperproliferative diseases. Further, inhibition of Aurora kinases as a therapeutic approach to these diseases may have significant advantages over targeting signalling pathways upstream of the cell cycle (e.g. those activated by growth factor receptor tyrosine kinases such as epidermal growth

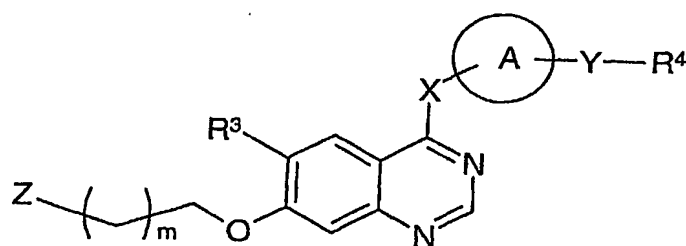
factor receptor (EGFR) or other receptors). Since the cell cycle is ultimately downstream of all of these diverse signalling events, cell cycle directed therapies such as inhibition of Aurora kinases would be predicted to be active across all proliferating tumour cells, whilst approaches directed at specific signalling molecules (e.g. EGFR) would be predicted to be active only in the subset of tumour cells which express those receptors. It is also believed that significant "cross talk" exists between these signalling pathways meaning that inhibition of one component may be compensated for by another.

A number of quinazoline derivatives have been proposed hitherto for use in the inhibition of various kinases. For example, WO 96/09294, WO 96/15118 and WO 99/06378 describe the use of certain quinazoline compounds as receptor tyrosine kinase inhibitors, which may be useful in the treatment of proliferative disease and WO 00/21955 discloses certain quinazoline derivatives as inhibitors of the effects of VEGF.

Quinazoline derivatives have also been disclosed for use in the inhibition of Aurora-A kinase. WO 01/21597 discloses quinazoline derivative bearing a 6-membered aromatic ring containing at least one nitrogen atom. However despite the compounds of WO 01/21597 there still exists the need for further compounds having Aurora kinase inhibitory properties.

The applicants have been successful in finding a novel series of compounds which inhibit the effects of the Aurora kinases and in particular Aurora-A and Aurora-B kinase and which have certain properties that make them particularly useful in formulating medicaments for the treatment of disease. In particular the compounds are of use in the treatment of proliferative disease such as cancer, in particular in diseases such as colorectal, breast or pancreatic cancer where Aurora kinases are known to be active.

According to one aspect of the present invention there is provided a compound of formula (I):



formula (I)

wherein A is 6-membered heteroaryl containing a nitrogen atom and optionally containing one or two further nitrogen atoms;

X is O, S, S(O), S(O)<sub>2</sub> or NR<sup>14</sup>;

m is 0, 1, 2, 3 or 4;

Y is O, NR<sup>5</sup>CO, CONR<sup>5</sup>, CR<sup>6</sup>R<sup>7</sup>CONR<sup>5</sup> or CR<sup>6</sup>R<sup>7</sup>NR<sup>5</sup>;

Z is a group selected from -NR<sup>1</sup>R<sup>2</sup>, phosphonooxy, C<sub>3-6</sub>cycloalkyl (substituted by

- 5 phosphonooxy or C<sub>1-4</sub>alkyl (substituted by phosphonooxy)) and a 4- to 7-membered ring linked via a carbon atom containing a nitrogen atom and optionally containing a further nitrogen atom, which ring may be saturated, partially saturated or unsaturated wherein the ring is substituted on carbon or nitrogen by phosphonooxy or C<sub>1-4</sub>alkyl (substituted by phosphonooxy) and wherein the ring is optionally further substituted on carbon or nitrogen by
- 10 1, 2 or 3 halo or C<sub>1-4</sub>alkyl groups;

R<sup>1</sup> is -COR<sup>8</sup>, -CONR<sup>8</sup>R<sup>9</sup> or C<sub>1-6</sub>alkyl (substituted by phosphonooxy and optionally further substituted by 1 or 2 halo or methoxy groups);

R<sup>2</sup> is hydrogen, -COR<sup>10</sup>, -CONR<sup>10</sup>R<sup>11</sup>, C<sub>1-6</sub>alkyl (optionally substituted by 1, 2 or 3 halo or C<sub>1-4</sub>alkoxy groups or -S(O)<sub>p</sub>R<sup>11</sup> (where p is 0, 1 or 2) or phosphonooxy), C<sub>2-6</sub>alkenyl, C<sub>2-</sub>

- 15 <sub>6</sub>alkynyl, C<sub>3-6</sub>cycloalkyl and C<sub>3-6</sub>cycloalkylC<sub>1-4</sub>alkyl;

or R<sup>1</sup> and R<sup>2</sup> together with the nitrogen to which they are attached form a 4- to 7- membered ring optionally containing a further nitrogen atom which may be saturated, partially saturated or unsaturated wherein the ring is substituted on carbon or nitrogen by a group selected from phosphonooxy and C<sub>1-4</sub>alkyl (substituted by phosphonooxy or -NR<sup>8</sup>R<sup>9</sup>) and where the ring is

- 20 optionally further substituted on carbon or nitrogen by 1, 2 or 3 halo or C<sub>1-4</sub>alkyl groups;

R<sup>3</sup> is hydrogen, halo, cyano, nitro, C<sub>1-6</sub>alkoxy, C<sub>1-6</sub>alkyl, -OR<sup>12</sup>, -CHR<sup>12</sup>R<sup>13</sup>, -OC(O)R<sup>12</sup>, -C(O)R<sup>12</sup>, -NR<sup>12</sup>C(O)R<sup>13</sup>, -C(O)NR<sup>12</sup>R<sup>13</sup>, -NR<sup>12</sup>SO<sub>2</sub>R<sup>13</sup> or -NR<sup>12</sup>R<sup>13</sup>;

R<sup>4</sup> is hydrogen or a group selected from C<sub>1-4</sub>alkyl, heteroaryl, heteroarylC<sub>1-4</sub>alkyl, aryl and arylC<sub>1-4</sub>alkyl where the group is optionally substituted by 1, 2 or 3 substituents selected from

- 25 halo, methyl, ethyl, cyclopropyl and ethynyl;

R<sup>5</sup> is selected from hydrogen, C<sub>1-4</sub>alkyl, C<sub>2-4</sub>alkenyl, C<sub>2-4</sub>alkynyl, C<sub>3-6</sub>cycloalkyl and C<sub>3-6</sub>cycloalkylC<sub>1-4</sub>alkyl;

R<sup>6</sup> and R<sup>7</sup> are independently hydrogen, halo, C<sub>1-4</sub>alkyl, C<sub>3-6</sub>cycloalkyl, hydroxy and C<sub>1-4</sub>alkoxy;

- 30 R<sup>8</sup> is C<sub>1-4</sub>alkyl substituted by phosphonooxy and optionally further substituted by 1 or 2 halo or methoxy groups;

R<sup>9</sup> is hydrogen or C<sub>1-4</sub>alkyl;

R<sup>10</sup> is hydrogen or C<sub>1-4</sub>alkyl (optionally substituted by halo, C<sub>1-4</sub>alkoxy, S(O)<sub>q</sub> (where q is 0, 1 or 2) or phosphonoxy);

R<sup>11</sup>, R<sup>12</sup>, R<sup>13</sup> and R<sup>14</sup> are independently hydrogen, C<sub>1-4</sub>alkyl or heterocyclyl; or a pharmaceutically acceptable salt thereof.

5        Within the present invention, it is to be understood that, insofar as certain of compounds of formula (I) herein defined may exist in optically active or racemic forms by virtue of one or more asymmetric carbon or sulphur atoms, the invention includes in its definition any such optically active or racemic form which possesses aurora kinase inhibitory activity and in particular Aurora-A and/or Aurora-B kinase inhibitory activity. The synthesis  
10 of optically active forms may be carried out by standard techniques of organic chemistry well known in the art, for example by synthesis from optically active starting materials or by resolution of a racemic form. Similarly, the above-mentioned activity may be evaluated using the standard laboratory techniques referred to hereinafter.

      Within the present invention it is to be understood that a compound of formula (I) or a  
15 salt thereof may exhibit the phenomenon of tautomerism and that the formulae drawings within this specification can represent only one of the possible tautomeric forms. It is to be understood that the invention encompasses any tautomeric form which has Aurora kinase inhibitory activity and in particular Aurora-A and/or Aurora-B kinase inhibitory activity and is not to be limited merely to any one tautomeric form utilised within the formulae drawings.

20        It is also to be understood that certain compounds of formula (I) and salts thereof can exist in solvated as well as unsolvated forms such as, for example, hydrated forms. It is to be understood that the invention encompasses all such solvated forms which have Aurora kinase inhibitory activity and in particular Aurora-A and/or Aurora-B kinase inhibitory activity.

      The present invention relates to the compounds of formula (I) as hereinbefore defined  
25 as well as to the salts thereof. Salts for use in pharmaceutical compositions will be pharmaceutically acceptable salts, but other salts may be useful in the production of the compounds of formula (I) and their pharmaceutically acceptable salts. Pharmaceutically acceptable salts of the invention may, for example, include acid addition salts of compounds of formula (I) as hereinbefore defined which are sufficiently basic to form such salts. Such  
30 acid addition salts include but are not limited to fumarate, methanesulphonate, hydrochloride, hydrobromide, citrate and maleate salts and salts formed with phosphoric and sulphuric acid. In addition where compounds of formula (I) are sufficiently acidic, salts are base salts and examples include but are not limited to, an alkali metal salt for example sodium or potassium,

an alkaline earth metal salt for example calcium or magnesium, or organic amine salt for example triethylamine, ethanolamine, diethanolamine, triethanolamine, morpholine, *N*-methylpiperidine, *N*-ethylpiperidine, dibenzylamine or amino acids such as lysine.

The compounds of formula (I) may also be provided as *in vivo* hydrolysable esters.

- 5 An *in vivo* hydrolysable ester of a compound of formula (I) containing carboxy or hydroxy group is, for example a pharmaceutically acceptable ester which is cleaved in the human or animal body to produce the parent acid or alcohol. Such esters can be identified by administering, for example, intravenously to a test animal, the compound under test and subsequently examining the test animal's body fluid.
- 10 Suitable pharmaceutically acceptable esters for carboxy include C<sub>1-6</sub>alkoxymethyl esters for example methoxymethyl, C<sub>1-6</sub>alkanoyloxymethyl esters for example pivaloyloxymethyl, phthalidyl esters, C<sub>3-8</sub>cycloalkoxycarbonyloxyC<sub>1-6</sub>alkyl esters for example 1-cyclohexylcarbonyloxyethyl; 1,3-dioxolen-2-onylmethyl esters for example 5-methyl-1,3-dioxolen-2-onylmethyl; and C<sub>1-6</sub>alkoxycarbonyloxyethyl esters for example 15 1-methoxycarbonyloxyethyl and may be formed at any carboxy group in the compounds of this invention.

- Suitable pharmaceutically-acceptable esters for hydroxy include inorganic esters such as phosphate esters (including phosphoramidic cyclic esters) and  $\alpha$ -acyloxyalkyl ethers and related compounds which as a result of the *in-vivo* hydrolysis of the ester breakdown to give
- 20 the parent hydroxy group/s. Examples of  $\alpha$ -acyloxyalkyl ethers include acetoxymethoxy and 2,2-dimethylpropionyloxymethoxy. A selection of *in-vivo* hydrolysable ester forming groups for hydroxy include C<sub>1-10</sub>alkanoyl, for example formyl, acetyl; benzoyl; phenylacetyl; substituted benzoyl and phenylacetyl, C<sub>1-10</sub>alkoxycarbonyl (to give alkyl carbonate esters), for example ethoxycarbonyl; di-C<sub>1-4</sub>alkylcarbamoyl and *N*-(di-C<sub>1-4</sub>alkylaminoethyl)-*N*-
  - 25 C<sub>1-4</sub>alkylcarbamoyl (to give carbamates); di-C<sub>1-4</sub>alkylaminoacetyl and carboxyacetyl. Examples of ring substituents on phenylacetyl and benzoyl include aminomethyl, C<sub>1-4</sub>alkylaminomethyl and di-(C<sub>1-4</sub>alkyl)aminomethyl, and morpholino or piperazino linked from a ring nitrogen atom via a methylene linking group to the 3- or 4- position of the benzoyl ring. Other interesting *in vivo* hydrolysable esters include, for example, R<sup>A</sup>C(O)OC<sub>1-6</sub>alkyl-CO-,
  - 30 wherein R<sup>A</sup> is for example, benzyloxy-C<sub>1-4</sub>alkyl, or phenyl). Suitable substituents on a phenyl group in such esters include, for example, 4-C<sub>1-4</sub>piperazino-C<sub>1-4</sub>alkyl, piperazino-C<sub>1-4</sub>alkyl and morpholino-C<sub>1-4</sub>alkyl.



In this specification the generic term "alkyl" includes both straight-chain and branched-chain alkyl groups. However references to individual alkyl groups such as "propyl" are specific for the straight chain version only and references to individual branched-chain alkyl groups such as "*tert*-butyl" are specific for the branched chain version only. An  
5 analogous convention applies to other generic terms, for example "alkenyl" and "alkynyl".

"Cycloalkyl" is a monocyclic, saturated alkyl ring and "aryl" is monocyclic or bicyclic.

Unless otherwise specified "heteroaryl" is a monocyclic or bicyclic aromatic ring containing 5 to 10 ring atoms of which 1, 2, 3 or 4 ring atoms are chosen from nitrogen,  
10 sulphur or oxygen where a ring nitrogen or sulphur may be oxidised.

"Heterocyclyl" is a saturated, partially saturated or unsaturated, monocyclic or bicyclic ring containing 4 to 12 atoms of which 1, 2, 3 or 4 ring atoms are chosen from nitrogen, sulphur or oxygen, which may be carbon or nitrogen linked, wherein a -CH<sub>2</sub>- group can optionally be replaced by a -C(O)-; wherein a ring nitrogen or sulphur atom is optionally  
15 oxidised to form the N-oxide or S-oxide(s); wherein a ring -NH is optionally substituted by acetyl, formyl, methyl or mesyl; and wherein a ring is optionally substituted by one or more halo.

"Phosphonooxy" is in one aspect a group of formula -OP(O)(OH)<sub>2</sub>. However the term "phosphonooxy" also includes salts such as those formed with alkali metal ions such as  
20 sodium or potassium ions or alkaline earth metal ions, for example calcium or magnesium ions.

Where optional substituents are chosen from "1 or 2", from "1, 2, or 3" or from "1, 2, 3 or 4" groups or substituents it is to be understood that this definition includes all substituents being chosen from one of the specified groups i.e. all substituents being the same  
25 or the substituents being chosen from two or more of the specified groups i.e. the substituents not being the same.

Compounds of the present invention have been named with the aid of computer software (ACD/Name version 6.6 or ACD Name Batch version 6.0).

Suitable values for any R group (R<sup>1</sup> to R<sup>14</sup>) or any part or substituent for such groups  
30 include:

for C <sub>1-4</sub> alkyl:	methyl, ethyl, propyl, isopropyl, butyl, 2-methylpropyl and <i>tert</i> -butyl;
for C <sub>1-6</sub> alkyl:	C <sub>1-4</sub> alkyl, pentyl, 2,2-dimethylpropyl, 3-methylbutyl and hexyl;
for C <sub>2-4</sub> alkenyl:	vinyl, allyl and 1-propenyl;

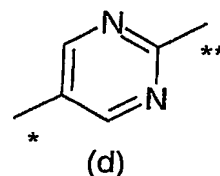
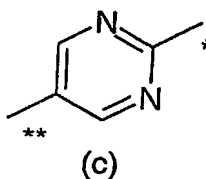
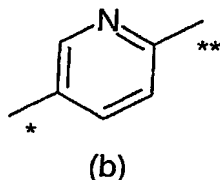
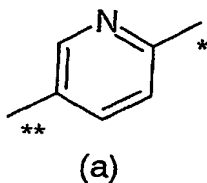
- for C<sub>2-6</sub>alkenyl: C<sub>2-4</sub>alkenyl, 1-butenyl, 2-butenyl, 3-butenyl, 2-methylbut-2-enyl, 3-methylbut-1-enyl, 1-pentenyl, 3-pentenyl and 4-hexenyl;
- for C<sub>2-4</sub>alkynyl: ethynyl, 1-propynyl, 2-propynyl and 3-butynyl;
- for C<sub>2-6</sub>alkynyl: C<sub>2-4</sub>alkynyl, 2-pentynyl, hexynyl and 1-methylpent-2-ynyl;
- 5 for C<sub>3-6</sub>cycloalkyl: cyclopropyl, cyclobutyl, cyclopentyl and cyclohexyl;
- for C<sub>3-6</sub>cycloalkylC<sub>1-4</sub>alkyl: cyclopropylmethyl, cyclopropylethyl, cyclobutylmethyl, cyclopentylmethyl and cyclohexylmethyl;
- for aryl: phenyl and naphthyl;
- for arylC<sub>1-4</sub>alkyl: benzyl, phenethyl, naphthylmethyl and naphthylethyl;
- 10 for halo: fluoro, chloro, bromo and iodo;
- for C<sub>1-4</sub>alkoxy: methoxy, ethoxy, propoxy and isopropoxy;
- for C<sub>1-6</sub>alkoxy: C<sub>1-4</sub>alkoxy, pentyloxy, 1-ethylpropoxy and hexyloxy;
- for heteroaryl: pyridyl, imidazolyl, quinolinyl, cinnolyl, pyrimidinyl, thiophenyl, pyrrolyl, pyrazolyl, thiazolyl, triazolyl, oxazolyl, isoxazolyl and
- 15 pyrazinyl and preferably thiazolyl, pyridyl, imidazolyl and pyrimidinyl;
- for heteroarylC<sub>1-4</sub>alkyl: pyridylmethyl, pyridylethyl, pyrimidinylethyl, pyrimidinylpropyl, pyrimidinylbutyl, imidazolylpropyl, imidazolylbutyl, quinolinylpropyl, 1,3,4-triazolylpropyl and oxazolylmethyl;
- 20 for heterocyclyl: furyl, thienyl, pyrrolyl, pyrrolidinyl, imidazolyl, triazolyl, thiazolyl, tetrazolyl, oxazolyl, isoxazolyl, pyrazolyl, pyridyl, pyrimidinyl, pyrazinyl, pyridazinyl, triazinyl, quinolinyl, isoquinolinyl, quinoxalinyl, benzothiazolyl, benzoxazolyl, benzothienyl, benzofuryl, piperidinyl, *N*-acetylpiperidinyl, *N*-methylpiperidinyl, *N*-formylpiperazinyl, *N*-mesylpiperazinyl, homopiperazinyl, piperazinyl, azetidyl, oxetanyl, morpholinyl, tetrahydroisoquinolinyl, tetrahydroquinolinyl, indolinyl, pyranyl, dihydro-2*H*-pyranyl, tetrahydrofuranlyl, 2,5-dioximidazolidinyl, 2,2-dimethyl-1,3-dioxolanyl and 3,4-dimethylenedioxybenzyl.
- 25
- 30

It should be noted that examples given for terms used in the description are not limiting.

Preferred values of A, X, m, Y, Z, R<sup>3</sup> and R<sup>4</sup> are as follows. Such values may be used where appropriate with any of the definitions, claims or embodiments defined hereinbefore or

hereinafter.

In one aspect of the invention A is pyridyl or pyrimidinyl. In a further aspect A is a group of formula (a), (b), (c) or (d):



5 where \* is the point of attachment to the X group of formula (I) and \*\* is the point of attachment to the Y group of formula (I). In a preferred aspect A is a group of formula (b) or (d).

In one aspect of the invention X is  $\text{NR}^{14}$ , O or S. In another aspect X is  $\text{NR}^{14}$ . In yet another aspect X is NH.

10 In one aspect of the invention Y is O,  $\text{NR}^5\text{CO}$  or  $\text{CR}^6\text{R}^7\text{NR}^5$ . In another aspect Y is O,  $\text{NHCO}$  or  $\text{CH}_2\text{NH}$ .

In one aspect of the invention Z is a group selected from  $-\text{NR}^1\text{R}^2$ , phosphonooxy, cyclopropyl (substituted by  $\text{C}_{1-4}$ alkyl (substituted by phosphonooxy)) and piperidine or piperazine ring linked via carbon where the ring is substituted on carbon or nitrogen by phosphonooxy or  $\text{C}_{1-4}$ alkyl (substituted by phosphonooxy). In another aspect Z is  $-\text{NR}^1\text{R}^2$ .

15 In one aspect of the invention  $\text{R}^1$  is  $\text{C}_{1-5}$ alkyl substituted by phosphonooxy. In another aspect  $\text{R}^1$  is  $\text{C}_{1-5}$ alkyl substituted by phosphonooxy and further substituted by 1 or 2 halo. In a further aspect  $\text{R}^1$  is 2-phosphonooxyethyl, 2-phosphonooxy-1,1-dimethylethyl, 2-phosphonooxy-2-methylethyl, 3-phosphonooxy-1,1-dimethylpropyl, 3-phosphonooxypropyl and 4-phosphonooxybutyl. In yet another aspect  $\text{R}^1$  is 2-phosphonooxyethyl, 3-phosphonooxy-1,1-dimethylpropyl or 4-phosphonooxybutyl.

20 In one aspect of the invention  $\text{R}^2$  is hydrogen,  $\text{C}_{1-6}$ alkyl (optionally substituted by 1, 2 or 3 halo or  $\text{C}_{1-4}$ alkoxy groups),  $\text{C}_{2-6}$ alkenyl,  $\text{C}_{2-6}$ alkynyl,  $\text{C}_{3-6}$ cycloalkyl and  $\text{C}_{3-6}$ cycloalkyl $\text{C}_{1-4}$ alkyl. In another aspect  $\text{R}^2$  is hydrogen, allyl, 2-propynyl, methyl, ethyl, propyl, isopropyl, 2-methylpropyl, butyl, 2,2-dimethylpropyl, cyclopropyl, cyclopropylmethyl, cyclobutyl, cyclobutylmethyl, cyclopentyl, cyclohexyl, cyclopentylmethyl, 3,3,3-trifluoropropyl and 2-methoxyethyl. In a further aspect  $\text{R}^2$  is hydrogen, methyl, ethyl isopropyl or cyclohexyl.

25 In one aspect of the invention  $\text{R}^1$  and  $\text{R}^2$  together with the nitrogen to which they are attached form a saturated 5- to 6-membered ring optionally containing a further nitrogen atom  
30 wherein the ring is substituted on carbon or nitrogen by a group selected from phosphonooxy and  $\text{C}_{1-4}$ alkyl (substituted by phosphonooxy or  $-\text{NR}^8\text{R}^9$ ) and where the ring is optionally

further substituted on carbon or nitrogen by 1 or 2 C<sub>1-4</sub>alkyl groups. In another aspect of the invention R<sup>1</sup> and R<sup>2</sup> together with the nitrogen to which they are attached form a piperidine, pyrrolidine or piperazine ring which is substituted on carbon or nitrogen by a group selected from phosphonooxy, phosphonooxymethyl and 2-phosphonooxyethyl and where the ring is  
 5 optionally further substituted on carbon or nitrogen by 1 or 2 methyl. In a further aspect of the invention R<sup>1</sup> and R<sup>2</sup> together with the nitrogen to which they are attached form 4-(phosphonooxymethyl)piperidinyl, 2-(phosphonooxymethyl)piperidinyl, 2-(phosphonooxymethyl)pyrrolidinyl, 4-(2-phosphonooxyethyl)piperazinyl, 3-(phosphonooxy)pyrrolidinyl, 3-(phosphonooxy)piperidinyl, 4-(phosphonooxy)piperidinyl, 2-  
 10 (phosphonooxymethyl)pyrrolidinyl, 4-(2-phosphonooxyethyl)piperidinyl, 2-(2-phosphonooxyethyl)pyrrolidinyl and 2-(2-phosphonooxyethyl)piperidinyl. In yet another aspect R<sup>1</sup> and R<sup>2</sup> together with the nitrogen to which they are attached form 2-(phosphonooxymethyl)piperidinyl, 4-(phosphonooxy)piperidinyl, 4-(2-phosphonooxyethyl)piperidinyl, 2-(2-phosphonooxyethyl)piperidinyl and 2-  
 15 (phosphonooxymethyl)pyrrolidinyl.

In one aspect of the invention R<sup>3</sup> is C<sub>1-4</sub>alkoxy or hydrogen. In another aspect R<sup>3</sup> is methoxy. In another aspect R<sup>3</sup> is hydrogen.

In one aspect R<sup>4</sup> is phenyl or benzyl optionally substituted by 1 or 2 of fluoro or chloro. In another aspect R<sup>4</sup> is 3-fluorophenyl, 3-chlorophenyl, 3-chlorobenzyl, 3,5-  
 20 difluorophenyl, 3,4-difluorophenyl, 2-fluorophenyl, 2,3-difluorophenyl, 2,4-difluorophenyl, 2,5-difluorophenyl, 3-chloro-4-fluorophenyl and 3-chloro-4-fluorobenzyl. In a further aspect R<sup>4</sup> is 3-fluorophenyl, 3-chlorophenyl, 3-chlorobenzyl, 3,4-difluorophenyl, 3-chloro-4-fluorophenyl and 3-chloro-4-fluorobenzyl.

In one aspect R<sup>5</sup> is hydrogen or methyl.

25 In one aspect of the invention R<sup>6</sup> is hydrogen, fluoro, chloro or methyl. In another aspect R<sup>6</sup> is hydrogen.

In one aspect of the invention R<sup>7</sup> is hydrogen, fluoro, chloro or methyl. In another aspect R<sup>7</sup> is hydrogen.

In one aspect R<sup>8</sup> is 2-phosphonooxyethyl.

30 In one aspect of the invention R<sup>9</sup> is hydrogen, methyl or ethyl.

In one aspect of the invention R<sup>10</sup> is hydrogen, methyl or ethyl.

In one aspect of the invention R<sup>11</sup> is hydrogen, methyl or ethyl.

In one aspect of the invention R<sup>12</sup> is hydrogen or methyl.

In one aspect of the invention  $R^{13}$  is hydrogen or methyl.

In one aspect of the invention  $R^{14}$  is hydrogen or methyl.

A preferred class of compounds is of formula (I) wherein:

A is a group of formula (a), (b), (c) or (d) as defined above;

5 X is  $NH$ ;

m is 0, 1, 2, 3 or 4;

Y is O,  $NR^5CO$  or  $CR^6R^7NR^5$

10 Z is  $-NR^1R^2$ , phosphonooxy, cyclopropyl (substituted by  $C_{1-4}$ alkyl (substituted by phosphonooxy)) and piperidine or piperazine ring linked via a carbon atom where the ring is substituted on carbon or nitrogen by phosphonooxy or  $C_{1-4}$ alkyl (substituted by phosphonooxy);

$R^1$  is  $C_{1-5}$ alkyl substituted by phosphonooxy;

$R^2$  is hydrogen,  $C_{1-6}$ alkyl (optionally substituted by 1, 2 or 3 halo or  $C_{1-4}$ alkoxy groups),  $C_{2-6}$ alkenyl,  $C_{2-6}$ alkynyl,  $C_{3-6}$ cycloalkyl and  $C_{3-6}$ cycloalkyl $C_{1-4}$ alkyl;

15  $R^3$  is  $C_{1-4}$ alkoxy or hydrogen;

$R^4$  is phenyl or benzyl optionally substituted by 1 or 2 of fluoro or chloro;

$R^5$  is hydrogen or methyl; and

$R^6$  and  $R^7$  are independently hydrogen, fluoro, chloro or methyl;

or a pharmaceutically acceptable salt thereof.

20 Another preferred class of compounds is of formula (I) wherein:

A is a group of formula (b) or (d) as defined above;

X is  $NH$ ;

m is 0, 1, 2, 3 or 4;

Y is O,  $NR^5CO$  or  $CR^6R^7NR^5$

25 Z is  $-NR^1R^2$ , phosphonooxy, cyclopropyl (substituted by  $C_{1-4}$ alkyl (substituted by phosphonooxy)) and piperidine or piperazine ring linked via a carbon atom where the ring is substituted on carbon or nitrogen by phosphonooxy or  $C_{1-4}$ alkyl (substituted by phosphonooxy);

$R^1$  is  $C_{1-5}$ alkyl substituted by phosphonooxy;

30  $R^2$  is hydrogen,  $C_{1-6}$ alkyl (optionally substituted by 1, 2 or 3 halo or  $C_{1-4}$ alkoxy groups),  $C_{2-6}$ alkenyl,  $C_{2-6}$ alkynyl,  $C_{3-6}$ cycloalkyl and  $C_{3-6}$ cycloalkyl $C_{1-4}$ alkyl;

$R^3$  is  $C_{1-4}$ alkoxy or hydrogen;

$R^4$  is phenyl or benzyl optionally substituted by 1 or 2 of fluoro or chloro;

$R^5$  is hydrogen or methyl; and

$R^6$  and  $R^7$  are independently hydrogen, fluoro, chloro or methyl;

or a pharmaceutically acceptable salt thereof.

Another preferred class of compounds is of formula (I) wherein:

5 A is a group of formula (a), (b), (c) or (d) as defined above;

X is NH;

m is 0, 1, 2, 3 or 4;

Y is O,  $NR^5CO$  or  $CR^6R^7NR^5$

10 Z is  $-NR^1R^2$ , phosphonooxy, cyclopropyl (substituted by  $C_{1-4}$ alkyl (substituted by phosphonooxy)) and piperidine or piperazine ring where the ring is substituted by phosphonooxy or  $C_{1-4}$ alkyl (substituted by phosphonooxy);  
 $R^1$  and  $R^2$  together with the nitrogen to which they are attached form a piperidine, pyrrolidine or piperazine ring which is substituted on carbon or nitrogen by a group selected from phosphonooxy, phosphonooxymethyl and 2-phosphonooxyethyl and where the ring is  
 15 optionally further substituted on carbon or nitrogen by 1 or 2 methyl.

$R^3$  is  $C_{1-4}$ alkoxy or hydrogen;

$R^4$  is phenyl or benzyl optionally substituted by 1 or 2 of fluoro or chloro;

$R^5$  is hydrogen or methyl; and

$R^6$  and  $R^7$  are independently hydrogen, fluoro, chloro or methyl;

20 or a pharmaceutically acceptable salt thereof.

A further preferred class of compounds is of formula (I) wherein:

A is a group of formula (b) or (d) as defined above;

X is NH;

m is 0, 1, 2, 3 or 4;

25 Y is O,  $NR^5CO$  or  $CR^6R^7NR^5$

Z is  $-NR^1R^2$ , phosphonooxy, cyclopropyl (substituted by  $C_{1-4}$ alkyl (substituted by phosphonooxy)) and piperidine or piperazine ring where the ring is substituted by phosphonooxy or  $C_{1-4}$ alkyl (substituted by phosphonooxy);

30  $R^1$  and  $R^2$  together with the nitrogen to which they are attached form a piperidine, pyrrolidine or piperazine ring which is substituted on carbon or nitrogen by a group selected from phosphonooxy, phosphonooxymethyl and 2-phosphonooxyethyl and where the ring is optionally further substituted on carbon or nitrogen by 1 or 2 methyl.

$R^3$  is  $C_{1-4}$ alkoxy or hydrogen;

R<sup>4</sup> is phenyl or benzyl optionally substituted by 1 or 2 of fluoro or chloro;

R<sup>5</sup> is hydrogen or methyl; and

R<sup>6</sup> and R<sup>7</sup> are independently hydrogen, fluoro, chloro or methyl;

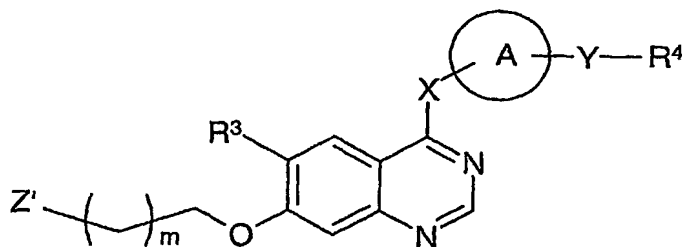
or a pharmaceutically acceptable salt thereof.

5 In another aspect of the invention, preferred compounds of the invention are any one of:

- 3-[(3-{[4-({6-[(3-chlorobenzyl)oxy]pyridin-3-yl} amino)-6-methoxyquinazolin-7-yl]oxy}propyl)amino]-3-methylbutyl dihydrogen phosphate;
- 3-[(3-{[4-({6-[(3-chlorobenzoyl)amino]pyridin-3-yl} amino)-6-methoxyquinazolin-7-yl]oxy}propyl)amino]-3-methylbutyl dihydrogen phosphate;
- 10 2-[(3-{[4-({6-[(3-chlorobenzoyl)amino]pyridin-3-yl} amino)-6-methoxyquinazolin-7-yl]oxy}propyl)(ethyl)amino]ethyl dihydrogen phosphate;
- 2-[1-(3-{[4-({6-[(3-chlorobenzoyl)amino]pyridin-3-yl} amino)-6-methoxyquinazolin-7-yl]oxy}propyl)piperidin-2-yl]ethyl dihydrogen phosphate;
- 15 [(2R)-1-(3-{[4-({6-[(3-chlorobenzoyl)amino]pyridin-3-yl} amino)-6-methoxyquinazolin-7-yl]oxy}propyl)pyrrolidin-2-yl]methyl dihydrogen phosphate;
- 2-[1-(3-{[4-({6-[(3-chlorobenzoyl)amino]pyridin-3-yl} amino)-6-methoxyquinazolin-7-yl]oxy}propyl)piperidin-4-yl]ethyl dihydrogen phosphate;
- 2-[ethyl(3-{[4-({6-[(3-fluorobenzoyl)amino]pyridin-3-yl} amino)-6-methoxyquinazolin-7-yl]oxy}propyl)amino]ethyl dihydrogen phosphate;
- 20 2-[(3-{[4-({6-[(3,4-difluorobenzoyl)amino]pyridin-3-yl} amino)-6-methoxyquinazolin-7-yl]oxy}propyl)(isopropyl)amino]ethyl dihydrogen phosphate;
- 1-(3-{[4-({6-[(3-chlorobenzoyl)amino]pyridin-3-yl} amino)-6-methoxyquinazolin-7-yl]oxy}propyl)piperidin-4-yl dihydrogen phosphate;
- 25 4-{[4-({6-[(3-chlorobenzoyl)amino]pyridin-3-yl} amino)-6-methoxyquinazolin-7-yl]oxy}butyl dihydrogen phosphate;
- 2-[(3-{[4-({6-[(3-chlorobenzoyl)amino]pyridin-3-yl} amino)-6-methoxyquinazolin-7-yl]oxy}propyl)(methyl)amino]ethyl dihydrogen phosphate;
- [1-(3-{[4-({6-[(3-chlorobenzoyl)amino]pyridin-3-yl} amino)-6-methoxyquinazolin-7-yl]oxy}propyl)piperidin-2-yl]methyl dihydrogen phosphate;
- 30 2-[(5-{[4-({6-[(3-chlorobenzoyl)amino]pyridin-3-yl} amino)-6-methoxyquinazolin-7-yl]oxy}pentyl)(ethyl)amino]ethyl dihydrogen phosphate;

- 4-[(3-{[4-({6-[(3-chlorobenzoyl)amino]pyridin-3-yl}amino)-6-methoxyquinazolin-7-yl]oxy}propyl)(ethyl)amino]butyl dihydrogen phosphate;
- 2-[(3-{[4-({6-[(3-fluorobenzoyl)amino]pyridin-3-yl}amino)-6-methoxyquinazolin-7-yl]oxy}propyl)(methyl)amino]ethyl dihydrogen phosphate;
- 5 2-[(3-{[4-({2-[(3-chloro-4-fluorobenzoyl)amino]pyrimidin-5-yl}amino)-6-methoxyquinazolin-7-yl]oxy}propyl)(cyclohexyl)amino]ethyl dihydrogen phosphate;
- 2-[(3-{[4-({2-[(3-chloro-4-fluorobenzoyl)amino]pyrimidin-5-yl}amino)-6-methoxyquinazolin-7-yl]oxy}propyl)(ethyl)amino]ethyl dihydrogen phosphate;
- 3-[(4-({2-[(3-chlorobenzoyl)amino]pyrimidin-5-yl}amino)-6-methoxyquinazolin-7-yl]oxy}propyl dihydrogen phosphate;
- 10 1-[3-({4-[(2-({(3-chloro-4-fluorophenyl)amino)methyl}pyrimidin-5-yl)amino]-6-methoxyquinazolin-7-yl}oxy)propyl]piperidin-4-yl dihydrogen phosphate;
- 3-[(3-({4-({2-[(3-chloro-4-fluorobenzoyl)oxy]pyrimidin-5-yl}amino)-6-methoxyquinazolin-7-yl]oxy}propyl)amino]-3-methylbutyl dihydrogen phosphate;
- 15 2-[(4-({4-({2-[(3-chloro-4-fluorobenzoyl)amino]pyrimidin-5-yl}amino)-6-methoxyquinazolin-7-yl]oxy)methyl)cyclopropyl]methyl dihydrogen phosphate; and
- 2-[4-({4-({2-[(3-chloro-4-fluorobenzoyl)amino]pyrimidin-5-yl}amino)-6-methoxyquinazolin-7-yl]oxy)methyl]piperidin-1-yl]ethyl dihydrogen phosphate.

In another aspect the present invention provides a process for the preparation of a  
 20 compound of formula (I) or a pharmaceutically acceptable salt thereof, which process comprises converting a compound of formula (II) into a compound of formula (I) by phosphorylation of an appropriate hydroxy group:



formula (II)

- 25 where A, X, m, Y, R<sup>2</sup>, R<sup>3</sup> and R<sup>4</sup> are as defined for formula (I); and Z' is a group selected from -NR<sup>1</sup>R<sup>2</sup>, hydroxy, C<sub>3-6</sub>cycloalkyl (substituted by hydroxy or C<sub>1-4</sub>alkyl (substituted by hydroxy)) and a 4- to 7-membered ring linked via a carbon atom, containing a nitrogen atom and optionally containing a further nitrogen atom, which ring may be saturated, partially



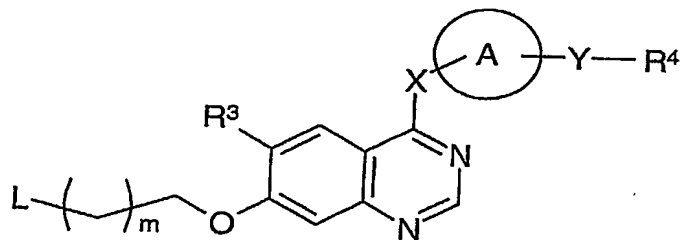
saturated or unsaturated wherein the ring is substituted on carbon or nitrogen by hydroxy or C<sub>1-4</sub>alkyl (substituted by hydroxy) and wherein the ring is optionally further substituted on carbon or nitrogen by 1, 2 or 3 halo or C<sub>1-4</sub>alkyl groups; R<sup>1'</sup> is -COR<sup>8'</sup>, -CONR<sup>8'</sup>R<sup>9</sup> or C<sub>1-6</sub>alkyl (substituted by hydroxy and optionally further substituted by 1 or 2 halo or methoxy groups); or R<sup>1'</sup> and R<sup>2</sup> together with the nitrogen to which they are attached form a 4- to 7-membered ring optionally containing a further nitrogen atom which may be saturated, partially saturated or unsaturated wherein the ring is substituted on carbon or nitrogen by a group selected from hydroxy and C<sub>1-4</sub>alkyl (substituted by hydroxy or -NR<sup>8'</sup>R<sup>9</sup>) and where the ring is optionally further substituted on carbon or nitrogen by 1, 2 or 3 halo or C<sub>1-4</sub>alkyl groups; and where R<sup>8'</sup> is C<sub>1-4</sub>alkyl substituted by hydroxy and optionally further substituted by 1 or 2 halo or methoxy groups:

and thereafter if necessary:

- i) converting a compound of the formula (I) into another compound of the formula (I);
- ii) removing any protecting groups;
- 15 iii) forming a pharmaceutically acceptable salt.

Phosphorylation may be suitably performed by treatment with 1-H tetrazole (or a suitable replacement such as S-ethyl tetrazole or pyridinium hydrochloride) and di-*tert*-butyldiethylphosphoramidite at 5 to 35 °C under an inert atmosphere for 30 minutes to 4 hours followed by treatment with an oxidizing agent such as meta-chloroperbenzoic acid (mCPBA) or 30% aqueous hydrogen peroxide at -10 to 25 °C for 2 to 18 hour. Deprotection of the *tert*-butyl groups to yield the phosphate group is required as a final step with these reagents and may be readily achieved by treatment with 4.0 N hydrochloric acid in 1,4-dioxane at 10 to 35 °C for 12 to 18 hours.

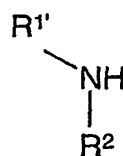
This process may further comprise a method for the preparation of a compound of 25 formula (II) where Z' is -NR<sup>1'</sup>R<sup>2</sup> which method comprises the reaction of a compound of formula (III) where L is a leaving group such as halo (e.g. chloro):



formula (III)

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with an amine of formula (IV):

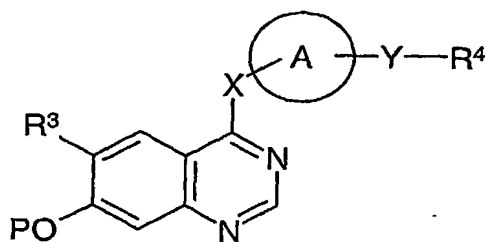


formula (IV).

Suitable reaction conditions for this process include heating a compound of formula (III) with  
 5 an excess of amine of formula (IV) in an inert solvent such as dimethylacetamide, with or without the addition of a suitable catalyst (such as *tetra*-*n*-butylammonium iodide or potassium iodide) at a temperature of 50 to 100 °C for 12 to 72 hours.

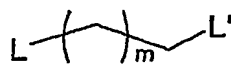
The amines of formula (IV) are known in the art or may be prepared by the skilled person using methods known in the art.

10 The process may further comprise a method for the preparation of a compound of formula (III) which method comprises the reaction of a compound of formula (V) where P is a suitable protecting group for a hydroxy group (such as benzyl):



formula (V)

15 by reaction with a compound of formula (VI) where L' is a leaving group such as halo (e.g. bromo):

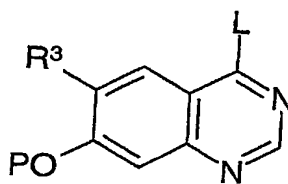


formula (VI)

Such a reaction can be achieved (after removal of the protecting group using a method  
 20 selected from those already described in the literature) under a range of conditions described in the literature such as heating a compound of formula (V) with a compound of formula (VI) in the presence of a catalyst such as caesium carbonate in a solvent such as acetonitrile at a temperature of 80 to 100 °C for 1 to 4 hours.

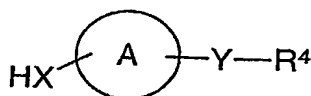
The process may further comprise a method for the preparation of a compound of  
 25 formula (V) where X is NR<sup>14</sup>, O or S which method comprises the reaction of a compound of

formula (VII) where L is a leaving group such as halo (e.g. chloro) and where P is a protecting group for a hydroxyl group (such as benzyl):



formula (VII)

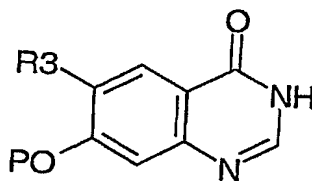
5 with a compound of formula (VIII)



formula (VIII)

Such a reaction can be achieved under a range of conditions described in the literature such as heating a compound of formula (VII) with a compound of formula (VIII) in a solvent such as isopropanol or dimethylacetamide (optionally in the presence of an acid catalyst such as hydrochloric acid) at a temperature of 80 to 100 °C for 2 to 6 hours. Alternatively the reaction may be effected using a base such as sodium hydride and carrying out the reaction in an inert solvent such as dimethylformamide at a temperature of 50 to 80 °C for 2 to 6 hours.

The process may further comprise a method for the preparation of a compound of formula (VII) which method comprises the reaction of a compound of formula (IX) where P is a protecting group for a hydroxy group (such as benzyl) with a chlorinating agent such as thionyl chloride, phosphorus oxychloride or phosphorus pentachloride.

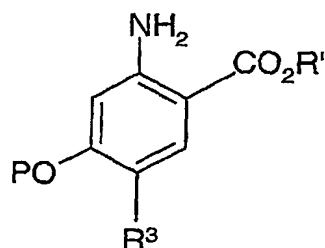


formula (IX)

20 Suitable reaction conditions are illustrated hereinafter.

A method for the preparation of a compound of formula (IX) comprises the reaction of a compound of formula (X) where R' may be either hydrogen or an alkyl, aryl or benzyl group and where P is a protecting group:

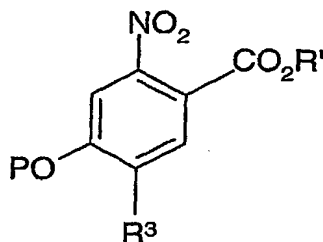
-18-



formula (X)

with formamide or a suitable equivalent (such as formamidine acetate). The reaction is suitably effected either by heating a compound of formula (X) in neat formamide or by  
 5 heating in a suitable solvent such as 2-methoxyethanol at elevated temperature, conveniently at the reflux temperature of the solvent.

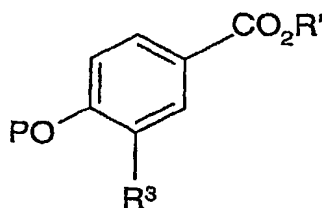
Compounds of formula (X) are either known compounds or they can be prepared by conventional methods. In particular, compounds of formula (X) may be prepared by reduction of the corresponding nitro compound of formula (XI) where R' may be either  
 10 hydrogen or an alkyl, aryl or benzyl group:



formula (XI)

Suitable reaction conditions are illustrated hereinafter.

Compounds of formula (XI) may be obtained by nitration of a compound of formula  
 15 (XII) where R' may be either hydrogen or an alkyl, aryl or benzyl group:

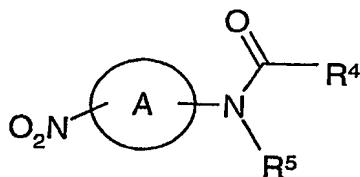


formula (XII)

for example, using nitric acid as the nitrating agent. Again, suitable reaction conditions are  
 20 illustrated hereinafter.

The compounds of formula (VIII) are known in the art or may be prepared by the skilled person using methods known in the art. However the process may further comprise a

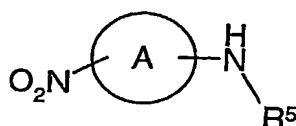
method for the preparation of a compound according to formula (VIII) where Y is  $\text{NR}^5\text{CO}$  and X is NH which method comprises the reduction of a compound of formula (XIII)



formula (XIII)

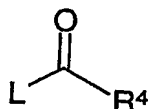
5 for example, using hydrogen (in the presence of a platinum or palladium catalyst) as a reducing agent. Again, suitable reaction conditions are illustrated hereinafter.

The process may further comprise a method for the preparation of a compound according to formula (XIII) which method comprises the reaction of a compound of formula (XIV)



formula (XIV)

with a compound of formula (XV) where L is an appropriate leaving group (such as carboxylate,  $(\text{C}_{1-10}\text{alkyl})\text{COO}$  or halo, such as chloro):



formula (XV)

Again, suitable reaction conditions are illustrated hereinafter.

It will be appreciated that certain of the various ring substituents in the compounds of the present invention may be introduced by standard aromatic substitution reactions or generated by conventional functional group modifications either prior to or immediately following the processes mentioned above, and as such are included in the process aspect of the invention. Such reactions and modifications include, for example, introduction of a substituent by means of an aromatic substitution reaction, reduction of substituents, alkylation of substituents and oxidation of substituents. The reagents and reaction conditions for such procedures are well known in the chemical art. Particular examples of aromatic substitution reactions include the introduction of a nitro group using concentrated nitric acid, the introduction of an acyl group using, for example, an acyl halide and Lewis acid (such as

aluminium trichloride) under Friedel Crafts conditions; the introduction of an alkyl group using an alkyl halide and Lewis acid (such as aluminium trichloride) under Friedel Crafts conditions; and the introduction of a halogen group. Particular examples of modifications include the reduction of a nitro group to an amino group by for example, catalytic

- 5 hydrogenation with a nickel catalyst or treatment with iron in the presence of hydrochloric acid with heating; oxidation of alkylthio to alkylsulphinyl or alkylsulphonyl.

It will also be appreciated that in some of the reactions mentioned herein it may be necessary/desirable to protect any sensitive groups in the compounds. The instances where protection is necessary or desirable and suitable methods for protection are known to those  
10 skilled in the art. Conventional protecting groups may be used in accordance with standard practice (for illustration see T.W. Green, Protective Groups in Organic Synthesis, John Wiley and Sons, 1991). Thus, if reactants include groups such as amino, carboxy or hydroxy it may be desirable to protect the group in some of the reactions mentioned herein.

A suitable protecting group for an amino or alkylamino group is, for example, an acyl  
15 group, for example an alkanoyl group such as acetyl, an alkoxycarbonyl group, for example a methoxycarbonyl, ethoxycarbonyl or *t*-butoxycarbonyl group, an arylmethoxycarbonyl group, for example benzyloxycarbonyl, or an aroyl group, for example benzoyl. The deprotection conditions for the above protecting groups necessarily vary with the choice of protecting group. Thus, for example, an acyl group such as an alkanoyl or alkoxycarbonyl group or an  
20 aroyl group may be removed for example, by hydrolysis with a suitable base such as an alkali metal hydroxide, for example lithium or sodium hydroxide. Alternatively an acyl group such as a *t*-butoxycarbonyl group may be removed, for example, by treatment with a suitable acid as hydrochloric, sulphuric or phosphoric acid or trifluoroacetic acid and an arylmethoxycarbonyl group such as a benzyloxycarbonyl group may be removed, for  
25 example, by hydrogenation over a catalyst such as palladium-on-carbon, or by treatment with a Lewis acid for example boron tris(trifluoroacetate). A suitable alternative protecting group for a primary amino group is, for example, a phthaloyl group which may be removed by treatment with an alkylamine, for example dimethylaminopropylamine, or with hydrazine.

A suitable protecting group for a hydroxy group is, for example, an acyl group, for  
30 example an alkanoyl group such as acetyl, an aroyl group, for example benzoyl, or an arylmethyl group, for example benzyl. The deprotection conditions for the above protecting groups will necessarily vary with the choice of protecting group. Thus, for example, an acyl group such as an alkanoyl or an aroyl group may be removed, for example, by hydrolysis with

a suitable base such as an alkali metal hydroxide, for example lithium or sodium hydroxide. Alternatively an arylmethyl group such as a benzyl group may be removed, for example, by hydrogenation over a catalyst such as palladium-on-carbon.

A suitable protecting group for a carboxy group is, for example, an esterifying group, 5 for example a methyl or an ethyl group which may be removed, for example, by hydrolysis with a base such as sodium hydroxide, or for example a *tert*-butyl group which may be removed, for example, by treatment with an acid, for example an organic acid such as trifluoroacetic acid, or for example a benzyl group which may be removed, for example, by hydrogenation over a catalyst such as palladium-on-carbon.

10 The protecting groups may be removed at any convenient stage in the synthesis using conventional techniques well known in the chemical art.

According to a further aspect of the invention there is provided a pharmaceutical composition which comprises a compound formula (I), or a pharmaceutically acceptable salt thereof, as defined hereinbefore in association with a pharmaceutically acceptable diluent or 15 carrier.

The compositions of the invention may be in a form suitable for oral use (for example as tablets, lozenges, hard or soft capsules, aqueous or oily suspensions, emulsions, dispersible powders or granules, syrups or elixirs), for topical use (for example as creams, ointments, gels, or aqueous or oily solutions or suspensions), for administration by inhalation (for 20 example as a finely divided powder or a liquid aerosol), for administration by insufflation (for example as a finely divided powder) or for parenteral administration (for example as a sterile aqueous or oily solution for intravenous, subcutaneous, intramuscular or intramuscular dosing or as a suppository for rectal dosing).

The compositions of the invention may be obtained by conventional procedures using 25 conventional pharmaceutical excipients, well known in the art. Thus, compositions intended for oral use may contain, for example, one or more colouring, sweetening, flavouring and/or preservative agents.

Therefore in a further aspect of the invention there is provided a compound of formula (I), or a pharmaceutically acceptable salt thereof, for use in therapy.

30 Further provided is a compound of formula (I), or a pharmaceutically acceptable salt thereof, for use as a medicament.

Additionally a compound of formula (I), or a pharmaceutically acceptable salt thereof is provided for use in a method of treatment of a warm-blooded animal such as man by

therapy.

In another aspect of the invention, there is provided the use of a compound of formula (I) or a pharmaceutically acceptable salt thereof, in the preparation of a medicament for the treatment of a disease where the inhibition of one or more Aurora kinase is beneficial. In particular it is envisaged that inhibition of Aurora-A kinase and/or Aurora-B kinase may be beneficial.

In another aspect of the invention, there is provided the use of a compound of formula (I) or a pharmaceutically acceptable salt thereof, in the preparation of a medicament for the treatment of hyperproliferative diseases such as cancer and in particular colorectal, breast or pancreatic cancer where Aurora-A is upregulated.

According to yet another aspect, there is provided a compound of formula (I) or a pharmaceutically acceptable salt thereof for use in the method of treating a human suffering from a disease in which the inhibition of one or more Aurora kinases is beneficial, comprising the steps of administering to a person in need thereof a therapeutically effective amount of a compound of formula (I) or a pharmaceutically acceptable salt thereof. In particular it is envisaged that inhibition of Aurora-A kinase and/or Aurora-B kinase may be beneficial.

Further provided is a compound of formula (I) or a pharmaceutically acceptable salt thereof for use in the method of treating a human suffering from a hyperproliferative disease such as cancer and in particular colorectal, breast or pancreatic cancer where Aurora-A is upregulated, comprising the steps of administering to a person in need thereof a therapeutically effective amount of a compound of formula (I) or a pharmaceutically acceptable salt thereof.

For the above mentioned therapeutic uses the dose administered will vary with the compound employed, the mode of administration, the treatment desired, the disorder indicated and the age and sex of the animal or patient. The size of the dose would thus be calculated according to well known principles of medicine.

In using a compound of formula (I) for therapeutic or prophylactic purposes it will generally be administered so that a daily dose in the range, for example, 0.05 mg/kg to 50 mg/kg body weight is received, given if required in divided doses. In general lower doses will be administered when a parenteral route is employed. Thus, for example, for intravenous administration, a dose in the range, for example, 0.05 mg/kg to 25 mg/kg body weight will generally be used. Similarly, for administration by inhalation, a dose in the range, for example, 0.05 mg/kg to 25 mg/kg body weight will be used.



The treatment defined hereinbefore may be applied as a sole therapy or may involve, in addition to the compound of the invention, conventional surgery or radiotherapy or chemotherapy. Such chemotherapy may include one or more of the following categories of anti-tumour agents :-

- 5 (i) antiproliferative/antineoplastic drugs and combinations thereof, as used in medical oncology, such as alkylating agents (for example cis-platin, carboplatin, cyclophosphamide, nitrogen mustard, melphalan, chlorambucil, busulphan and nitrosoureas); antimetabolites (for example antifolates such as fluoropyrimidines like 5-fluorouracil and tegafur, raltitrexed, methotrexate, cytosine arabinoside and hydroxyurea; antitumour antibiotics (for example
- 10 anthracyclines like adriamycin, bleomycin, doxorubicin, daunomycin, epirubicin, idarubicin, mitomycin-C, dactinomycin and mithramycin); antimitotic agents (for example vinca alkaloids like vincristine, vinblastine, vindesine and vinorelbine and taxoids like taxol and taxotere); and topoisomerase inhibitors (for example epipodophyllotoxins like etoposide and teniposide, amsacrine, topotecan and camptothecin);
- 15 (ii) cytostatic agents such as antioestrogens (for example tamoxifen, toremifene, raloxifene, droloxifene and idoxifene), antiandrogens (for example bicalutamide, flutamide, nilutamide and cyproterone acetate); LHRH antagonists or LHRH agonists (for example goserelin, leuprorelin and buserelin), progestogens (for example megestrol acetate), aromatase inhibitors (for example as anastrozole, letrozole, vorazole and exemestane) and inhibitors of
- 20 5 $\alpha$ -reductase such as finasteride;
- (iii) Agents which inhibit cancer cell invasion (for example metalloproteinase inhibitors like marimastat and inhibitors of urokinase plasminogen activator receptor function);
- (iv) inhibitors of growth factor function, for example such inhibitors include growth factor antibodies, growth factor receptor antibodies (for example the anti-erb2 antibody
- 25 trastuzumab [Herceptin<sup>TM</sup>] and the anti-erb3 antibody cetuximab [C225]), farnesyl transferase inhibitors, tyrosine kinase inhibitors and serine-threonine kinase inhibitors, for example inhibitors of the epidermal growth factor family (for example EGFR family tyrosine kinase inhibitors such as *N*-(3-chloro-4-fluorophenyl)-7-methoxy-6-(3-morpholinopropoxy)quinazolin-4-amine (gefitinib, AZD1839), *N*-(3-ethynylphenyl)-6,7-
- 30 bis(2-methoxyethoxy)quinazolin-4-amine (erlotinib, OSI-774) and 6-acrylamido-*N*-(3-chloro-4-fluorophenyl)-7-(3-morpholinopropoxy)quinazolin-4-amine (CI 1033)), for example inhibitors of the platelet-derived growth factor family and for example inhibitors of the hepatocyte growth factor family;

- (v) antiangiogenic agents such as those which inhibit the effects of vascular endothelial growth factor, (for example the anti-vascular endothelial cell growth factor antibody bevacizumab [Avastin<sup>TM</sup>], compounds such as those disclosed in International Patent Applications WO 97/22596, WO 97/30035, WO 97/32856 and WO 98/13354) and  
5 compounds that work by other mechanisms (for example linomide, inhibitors of integrin  $\alpha v \beta 3$  function and angiostatin);
- (vi) vascular damaging agents such as Combretastatin A4 and compounds disclosed in International Patent Applications WO 99/02166, WO00/40529, WO 00/41669, WO01/92224, WO02/04434 and WO02/08213;
- 10 (vii) antisense therapies, for example those which are directed to the targets listed above, such as ISIS 2503, an anti-ras antisense;
- (viii) gene therapy approaches, including for example approaches to replace aberrant genes such as aberrant p53 or aberrant BRCA1 or BRCA2, GDEPT (gene-directed enzyme pro-drug therapy) approaches such as those using cytosine deaminase, thymidine kinase or a bacterial  
15 nitroreductase enzyme and approaches to increase patient tolerance to chemotherapy or radiotherapy such as multi-drug resistance gene therapy; and
- (ix) immunotherapy approaches, including for example ex-vivo and in-vivo approaches to increase the immunogenicity of patient tumour cells, such as transfection with cytokines such as interleukin 2, interleukin 4 or granulocyte-macrophage colony stimulating factor,  
20 approaches to decrease T-cell anergy, approaches using transfected immune cells such as cytokine-transfected dendritic cells, approaches using cytokine-transfected tumour cell lines and approaches using anti-idiotypic antibodies.

Such conjoint treatment may be achieved by way of the simultaneous, sequential or separate dosing of the individual components of the treatment. Such combination products employ the  
25 compounds of this invention within the dosage range described hereinbefore and the other pharmaceutically-active agent within its approved dosage range.

In addition to their use in therapeutic medicine, the compounds of formula (I) and their pharmaceutically acceptable salts are also useful as pharmacological tools in the development and standardisation of *in vitro* and *in vivo* test systems for the evaluation of the effects of  
30 inhibitors of cell cycle activity in laboratory animals such as cats, dogs, rabbits, monkeys, rats and mice, as part of the search for new therapeutic agents.

In the above other pharmaceutical composition, process, method, use and medicament manufacture features, the alternative and preferred embodiments of the compounds of the invention described herein also apply.

The compounds of the invention inhibit the serine-threonine kinase activity of the Aurora kinases, in particular Aurora-A and/or Aurora-B and thus inhibit the cell cycle and cell proliferation. These properties may be assessed for example, using one or more of the procedures set out below.

(a) In Vitro Aurora-A kinase inhibition test

10 This assay determines the ability of a test compound to inhibit serine-threonine kinase activity. DNA encoding Aurora-A may be obtained by total gene synthesis or by cloning. This DNA may then be expressed in a suitable expression system to obtain polypeptide with serine-threonine kinase activity. In the case of Aurora-A, the coding sequence was isolated from cDNA by polymerase chain reaction (PCR) and cloned into the BamH1 and Not1  
15 restriction endonuclease sites of the baculovirus expression vector pFastBac HTc (GibcoBRL/Life technologies). The 5' PCR primer contained a recognition sequence for the restriction endonuclease BamH1 5' to the Aurora-A coding sequence. This allowed the insertion of the Aurora-A gene in frame with the 6 histidine residues, spacer region and rTEV protease cleavage site encoded by the pFastBac HTc vector. The 3' PCR primer replaced the  
20 Aurora-A stop codon with additional coding sequence followed by a stop codon and a recognition sequence for the restriction endonuclease Not1. This additional coding sequence (5' TAC CCA TAC GAT GTT CCA GAT TAC GCT TCT TAA 3') encoded for the polypeptide sequence YPYDVPDYAS. This sequence, derived from the influenza hemagglutinin protein, is frequently used as a tag epitope sequence that can be identified using  
25 specific monoclonal antibodies. The recombinant pFastBac vector therefore encoded for an N-terminally 6 his tagged, C terminally influenza hemagglutinin epitope tagged Aurora-A protein. Details of the methods for the assembly of recombinant DNA molecules can be found in standard texts, for example Sambrook et al. 1989, Molecular Cloning - A Laboratory Manual, 2<sup>nd</sup> Edition, Cold Spring Harbor Laboratory press and Ausubel et al. 1999, Current  
30 Protocols in Molecular Biology, John Wiley and Sons Inc.

Production of recombinant virus can be performed following manufacturer's protocol from GibcoBRL. Briefly, the pFastBac-1 vector carrying the Aurora-A gene was transformed into E. coli DH10Bac cells containing the baculovirus genome (bacmid DNA) and via a

transposition event in the cells, a region of the pFastBac vector containing gentamycin resistance gene and the Aurora-A gene including the baculovirus polyhedrin promoter was transposed directly into the bacmid DNA. By selection on gentamycin, kanamycin, tetracycline and X-gal, resultant white colonies should contain recombinant bacmid DNA  
5 encoding Aurora-A. Bacmid DNA was extracted from a small scale culture of several BH10Bac white colonies and transfected into *Spodoptera frugiperda* Sf21 cells grown in TC100 medium (GibcoBRL) containing 10% serum using CellFECTIN reagent (GibcoBRL) following manufacturer's instructions. Virus particles were harvested by collecting cell culture medium 72 hrs post transfection. 0.5 mls of medium was used to infect 100 ml suspension  
10 culture of Sf21s containing  $1 \times 10^7$  cells/ml. Cell culture medium was harvested 48 hrs post infection and virus titre determined using a standard plaque assay procedure. Virus stocks were used to infect Sf9 and "High 5" cells at a multiplicity of infection (MOI) of 3 to ascertain expression of recombinant Aurora-A protein.

For the large scale expression of Aurora-A kinase activity, Sf21 insect cells were  
15 grown at 28°C in TC100 medium supplemented with 10% foetal calf serum (Viralex) and 0.2% F68 Pluronic (Sigma) on a Wheaton roller rig at 3 r.p.m. When the cell density reached  $1.2 \times 10^6$  cells ml<sup>-1</sup> they were infected with plaque-pure Aurora-A recombinant virus at a multiplicity of infection of 1 and harvested 48 hours later. All subsequent purification steps were performed at 4°C. Frozen insect cell pellets containing a total of  $2.0 \times 10^8$  cells were  
20 thawed and diluted with lysis buffer (25 mM HEPES (N-[2-hydroxyethyl]piperazine-N'-[2-ethanesulphonic acid]) pH7.4 at 4°C, 100 mM KCl, 25 mM NaF, 1 mM Na<sub>3</sub>VO<sub>4</sub>, 1 mM PMSF (phenylmethylsulphonyl fluoride), 2 mM 2-mercaptoethanol, 2 mM imidazole, 1 µg/ml aprotinin, 1 µg/ml pepstatin, 1 µg/ml leupeptin), using 1.0 ml per  $3 \times 10^7$  cells. Lysis was achieved using a dounce homogeniser, following which the lysate was centrifuged at 41,000g  
25 for 35 minutes. Aspirated supernatant was pumped onto a 5 mm diameter chromatography column containing 500 µl Ni NTA (nitrilo-tri-acetic acid) agarose (Qiagen, product no. 30250) which had been equilibrated in lysis buffer. A baseline level of UV absorbance for the eluent was reached after washing the column with 12 ml of lysis buffer followed by 7 ml of wash buffer (25 mM HEPES pH7.4 at 4°C, 100 mM KCl, 20 mM imidazole, 2 mM 2-  
30 mercaptoethanol). Bound Aurora-A protein was eluted from the column using elution buffer (25 mM HEPES pH7.4 at 4°C, 100 mM KCl, 400 mM imidazole, 2 mM 2-mercaptoethanol). An elution fraction (2.5 ml) corresponding to the peak in UV absorbance was collected. The elution fraction, containing active Aurora-A kinase, was dialysed exhaustively against dialysis

buffer (25 mM HEPES pH7.4 at 4°C, 45% glycerol (v/v), 100 mM KCl, 0.25% Nonidet P40 (v/v), 1 mM dithiothreitol).

Each new batch of Aurora-A enzyme was titrated in the assay by dilution with enzyme diluent (25mM Tris-HCl pH7.5, 12.5mM KCl, 0.6mM DTT). For a typical batch, stock enzyme is diluted 1 in 666 with enzyme diluent & 20µl of dilute enzyme is used for each assay well. Test compounds (at 10mM in dimethylsulphoxide (DMSO)) were diluted with water & 10µl of diluted compound was transferred to wells in the assay plates. "Total" & "blank" control wells contained 2.5% DMSO instead of compound. Twenty microlitres of freshly diluted enzyme was added to all wells, apart from "blank" wells. Twenty microlitres of enzyme diluent was added to "blank" wells. Twenty microlitres of reaction mix (25mM Tris-HCl, 78.4mM KCl, 2.5mM NaF, 0.6mM dithiothreitol, 6.25mM MnCl<sub>2</sub>, 6.25mM ATP, 7.5µM peptide substrate [biotin-LRRWSLGLRRWSLGLRRWSLGLRRWSLG]) containing 0.2µCi [ $\gamma$ <sup>33</sup>P]ATP (Amersham Pharmacia, specific activity  $\geq 2500$  Ci/mmol) was then added to all test wells to start the reaction. The plates were incubated at room temperature for 60 minutes. To stop the reaction 100µl 20% v/v orthophosphoric acid was added to all wells. The peptide substrate was captured on positively-charged nitrocellulose P30 filtermat (Whatman) using a 96-well plate harvester (TomTek) & then assayed for incorporation of <sup>33</sup>P with a Beta plate counter. "Blank" (no enzyme) and "total" (no compound) control values were used to determine the dilution range of test compound which gave 50% inhibition of enzyme activity.

In this test, the compounds of the invention give 50% inhibition of enzyme activity at concentrations of 0.3nM to 1000nM and in particular compound 17 in Table 2 gave 50% inhibition of enzyme activity at a concentration of 0.3nM.

(b) In Vitro Aurora-B kinase inhibition test

This assay determines the ability of a test compound to inhibit serine-threonine kinase activity. DNA encoding Aurora-B may be obtained by total gene synthesis or by cloning. This DNA may then be expressed in a suitable expression system to obtain polypeptide with serine-threonine kinase activity. In the case of Aurora-B, the coding sequence was isolated from cDNA by polymerase chain reaction (PCR) and cloned into the pFastBac system in a manner similar to that described above for Aurora-A (i.e. to direct expression of a 6-histidine tagged Aurora-B protein).

For the large scale expression of Aurora-B kinase activity, Sf21 insect cells were grown at 28°C in TC100 medium supplemented with 10% foetal calf serum (Viralex) and

0.2% F68 Pluronic (Sigma) on a Wheaton roller rig at 3 r.p.m. When the cell density reached  $1.2 \times 10^6$  cells  $\text{ml}^{-1}$  they were infected with plaque-pure Aurora-B recombinant virus at a multiplicity of infection of 1 and harvested 48 hours later. All subsequent purification steps were performed at  $4^\circ\text{C}$ . Frozen insect cell pellets containing a total of  $2.0 \times 10^8$  cells were thawed and diluted with lysis buffer (50 mM HEPES (N-[2-hydroxyethyl]piperazine-N'-[2-ethanesulphonic acid]) pH7.5 at  $4^\circ\text{C}$ , 1 mM  $\text{Na}_3\text{VO}_4$ , 1 mM PMSF (phenylmethylsulphonyl fluoride), 1 mM dithiothreitol, 1  $\mu\text{g/ml}$  aprotinin, 1  $\mu\text{g/ml}$  pepstatin, 1  $\mu\text{g/ml}$  leupeptin), using 1.0 ml per  $2 \times 10^7$  cells. Lysis was achieved using a sonication homogeniser, following which the lysate was centrifuged at  $41,000g$  for 35 minutes. Aspirated supernatant was pumped onto a 5 mm diameter chromatography column containing 1.0 ml CM sepharose Fast Flow (Amersham Pharmacia Biotech) which had been equilibrated in lysis buffer. A baseline level of UV absorbance for the eluent was reached after washing the column with 12 ml of lysis buffer followed by 7 ml of wash buffer (50 mM HEPES pH7.4 at  $4^\circ\text{C}$ , 1 mM dithiothreitol). Bound Aurora-B protein was eluted from the column using a gradient of elution buffer (50 mM HEPES pH7.4 at  $4^\circ\text{C}$ , 0.6 M NaCl, 1 mM dithiothreitol, running from 0% elution buffer to 100% elution buffer over 15 minutes at a flowrate of 0.5 ml/min). Elution fractions (1.0 ml) corresponding to the peak in UV absorbance was collected. Elution fractions were dialysed exhaustively against dialysis buffer (25 mM HEPES pH7.4 at  $4^\circ\text{C}$ , 45% glycerol (v/v), 100 mM KCl, 0.05% (v/v) IGEPAL CA630 (Sigma Aldrich), 1 mM dithiothreitol). Dialysed fractions were assayed for Aurora-B kinase activity.

Each new batch of Aurora-B enzyme was titrated in the assay by dilution with enzyme diluent (25mM Tris-HCl pH7.5, 12.5mM KCl, 0.6mM DTT). For a typical batch, stock enzyme is diluted 1 in 40 with enzyme diluent & 20 $\mu\text{l}$  of dilute enzyme is used for each assay well. Test compounds (at 10mM in dimethylsulphoxide (DMSO) were diluted with water & 10 $\mu\text{l}$  of diluted compound was transferred to wells in the assay plates. "Total" & "blank" control wells contained 2.5% DMSO instead of compound. Twenty microlitres of freshly diluted enzyme was added to all wells, apart from "blank" wells. Twenty microlitres of enzyme diluent was added to "blank" wells. Twenty microlitres of reaction mix (25mM Tris-HCl, 78.4mM KCl, 2.5mM NaF, 0.6mM dithiothreitol, 6.25mM  $\text{MnCl}_2$ , 37.5mM ATP, 25 $\mu\text{M}$  peptide substrate [biotin-LRRWSLGLRRWSLGLRRWSLGLRRWSLG]) containing 0.2 $\mu\text{Ci}$  [ $\gamma^{33}\text{P}$ ]ATP (Amersham Pharmacia, specific activity  $\geq 2500\text{Ci/mmol}$ ) was then added to all test wells to start the reaction. The plates were incubated at room temperature for 60 minutes. To stop the reaction 100 $\mu\text{l}$  20% v/v orthophosphoric acid was added to all wells. The peptide

substrate was captured on positively-charged nitrocellulose P30 filtermat (Whatman) using a 96-well plate harvester (TomTek) & then assayed for incorporation of  $^{33}\text{P}$  with a Beta plate counter. "Blank" (no enzyme) and "total" (no compound) control values were used to determine the dilution range of test compound which gave 50% inhibition of enzyme activity.

- 5 In this test, the compounds of the invention give 50% inhibition of enzyme activity at concentrations of 0.3nM to 1000nM and in particular compound 17 in Table 2 gave 50% inhibition of enzyme activity at a concentration of 12.3nM.

(c) In Vitro cell proliferation assay

- 10 This and other assays can be used to determine the ability of a test compound to inhibit the growth of adherent mammalian cell lines, for example the human tumour cell line SW620 (ATCC CCL-227). This assay determines the ability of a test compound to inhibit the incorporation of the thymidine analogue, 5'-bromo-2'-deoxy-uridine (BrdU) into cellular DNA. SW620 or other adherent cells were typically seeded at  $1 \times 10^5$  cells per well in L-15
- 15 media (GIBCO) plus 5% foetal calf serum, 1% L-glutamine (100 $\mu\text{l}$  / well) in 96 well tissue culture treated 96 well plates (Costar) and allowed to adhere overnight. The following day the cells were dosed with compound (diluted from 10mM stock in DMSO using L-15 (with 5% FCS, 1% L-glutamine). Untreated control wells and wells containing a compound known to give 100% inhibition of BrdU incorporation were included on each plate. After 48 hours in
- 20 the presence / absence of test compound the ability of the cells to incorporate BrdU over a 2 hour labelling period was determined using a Boehringer (Roche) Cell Proliferation BrdU ELISA kit (cat. No. 1 647 229) according to manufacturers directions. Briefly, 15 $\mu\text{l}$  of BrdU labelling reagent (diluted 1:100 in media – L-15, 5% FCS, 1% L-glutamine) was added to each well and the plate returned to a humidified (+5%  $\text{CO}_2$ ) 37°C incubator for 2 hours. After
- 25 2 hours the labelling reagent was removed by decanting and tapping the plate on a paper towel. FixDenat solution (50 $\mu\text{l}$  per well) was added and the plates incubated at room temperature for 45mins with shaking. The FixDenat solution was removed by decanting and tapping the inverted plate on a paper towel. The plate was then washed once with phosphate buffered saline (PBS) and 100 $\mu\text{l}$  /well of Anti-BrdU-POD antibody solution (diluted 1:100 in
- 30 antibody dilution buffer) added. The plate was then incubated at room temperature with shaking for 90min. Unbound Anti-BrdU-POD antibody was removed by decanting and washing the plate 4 times with PBS before being blotted dry. TMB substrate solution was added (100 $\mu\text{l}$ /well) and incubated for approximately 10 minutes at room temperature with

shaking until a colour change was apparent. The optical density of the wells was then determined at 690nm wavelength using a Titertek Multiscan plate reader. The values from compound treated, untreated and 100% inhibition controls were used to determine the dilution range of a test compound that gave 50% inhibition of BrdU incorporation. The compounds of the invention are active at 0.3nM to 10000nM in this test and in particular compound 17 in table 2 was active at 300nM.

(d) In Vitro cell cycle analysis assay

This assay determines the ability of a test compound to arrest cells in specific phases of the cell cycle. Many different mammalian cell lines could be used in this assay and SW620 cells are included here as an example. SW620 cells were seeded at  $7 \times 10^5$  cells per T25 flask (Costar) in 5 ml L-15 (5% FCS, 1% L-glutamine). Flasks were then incubated overnight in a humidified 37°C incubator with 5% CO<sub>2</sub>. The following day, 5µl of L-15 (5% FCS, 1% L-glutamine) carrying the appropriate concentration of test compound solubilised in DMSO was added to the flask. A no compound control treatments was also included (0.5% DMSO). The cells were then incubated for a defined time (24 hours) with compound. After this time the media was aspirated from the cells and they were washed with 5ml of prewarmed (37°C) sterile PBSA, then detached from the flask by brief incubation with trypsin and followed by resuspension in 5ml of 1% Bovine Serum Albumin (BSA, Sigma-Aldrich Co.) in sterile PBSA. The samples were then centrifuged at 2200rpm for 10 min. The supernatant was aspirated to leave 200µl of the PBS/BSA solution. The pellet was resuspended in this 200µl of solution by pipetting 10 times to create a single cell suspension. One ml of ice-cold 80% ethanol was slowly added to each cell suspension and the samples stored at -20°C overnight or until required for staining. Cells were pelleted by centrifugation, ethanol aspirated off and pellets resuspended in 200µl PBS containing 100µg/ml RNase (Sigma Aldrich) & 10µg/ml Propidium Iodide (Sigma Aldrich). Cell suspensions were incubated at 37°C for 30min, a further 200µl PBS added and samples stored in the dark at 4°C overnight.

Each sample was then syringed 10 times using 21-gauge needle. The samples were then transferred to LPS tubes and DNA content per cell analysed by Fluorescence activated cell sorting (FACS) using a FACScan flow cytometer (Becton Dickinson). Typically 30,000 events were counted and recorded using CellQuest v1.1 software (Verity Software). Cell cycle distribution of the population was calculated using Modfit software (Verity Software)



and expressed as percentage of cells with 2N (G0/G1), 2N-4N (S phase) and with 4N (G2/M) DNA content.

The compounds of the invention are active in this test at 0.3nM to 10000nM and in particular compounds 17 in table 2 was active at 1.5µM

5

The invention will now be illustrated in the following non limiting examples, in which standard techniques known to the skilled chemist and techniques analogous to those described in these Examples may be used where appropriate, and in which, unless otherwise stated:

- (i) evaporations were carried out by rotary evaporation *in vacuo* and work up procedures were  
10 carried out after removal of residual solids such as drying agents by filtration;
- (ii) operations were carried out at ambient temperature, typically in the range 18-25°C and in air unless stated, or unless the skilled person would otherwise operate under an atmosphere of an inert gas such as argon;
- (iii) column chromatography (by the flash procedure) and medium pressure liquid  
15 chromatography (MPLC) were performed on Merck Kieselgel silica (Art. 9385);
- (iv) yields are given for illustration only and are not necessarily the maximum attainable;
- (v) the structures of the end products of the formula (I) were generally confirmed by nuclear (generally proton) magnetic resonance (NMR) and mass spectral techniques; proton magnetic resonance chemical shift values were measured in deuterated dimethyl sulphoxide (DMSO  $d_6$ )  
20 (unless otherwise stated) on the delta scale (ppm downfield from tetramethylsilane) using one of the following four instruments

- Varian Gemini 2000 spectrometer operating at a field strength of 300 MHz
- Bruker DPX300 spectrometer operating at a field strength of 300MHz
- JEOL EX 400 spectrometer operating at a field strength of 400 MHz
- 25 - Bruker Avance 500 spectrometer operating at a field strength of 500MHz

Peak multiplicities are shown as follows: s, singlet; d, doublet; dd, double doublet; t, triplet; q, quartet; qu, quintet; m, multiplet; br s, broad singlet.

- (vi) robotic synthesis was carried out using a Zymate XP robot, with solution additions via a Zymate Master Laboratory Station and stirred via a Stem RS5000 Reacto-Station at 25°C;
- 30 (vii) work up and purification of reaction mixtures from robotic synthesis was carried out as follows: evaporations were carried out *in vacuo* using a Genevac HT 4; column chromatography was performed using either an Anachem Sympur MPLC system on silica using 27 mm diameter columns filled with Merck silica (60 µm, 25 g); the structures of the

final products were confirmed by LCMS on a Waters 2890 / ZMD micromass system using the following and are quoted as retention time (RT) in minutes:

- Column: waters symmetry C18 3.5  $\mu$ m 4.6x50 mm  
Solvent A: H<sub>2</sub>O  
5 Solvent B: CH<sub>3</sub>CN  
Solvent C: methanol + 5% HCOOH  
Flow rate: 2.5 ml / min  
Run time: 5 minutes with a 4.5 minute gradient from 0-100% C  
Wavelength: 254 nm, bandwidth 10 nm  
10 Mass detector: ZMD micromass  
Injection volume 0.005 ml

(viii) Analytical LCMS for compounds which had not been prepared by robotic synthesis was performed on a Waters Alliance HT system using the following and are quoted as retention time (RT) in minutes:

- 15 Column: 2.0 mm x 5 cm Phenomenex Max-RP 80A  
Solvent A: Water  
Solvent B: Acetonitrile  
Solvent C: Methanol / 1% formic acid or Water / 1% formic acid  
Flow rate: 1.1 ml / min  
20 Run time: 5 minutes with a 4.5 minute gradient from 0-95% B + constant 5% solvent C  
Wavelength: 254 nm, bandwidth 10 nm  
Injection volume 0.005 ml  
Mass detector: Micromass ZMD

- 25 (ix) Preparative high performance liquid chromatography (HPLC) was performed on either - Waters preparative LCMS instrument, with retention time (RT) measured in minutes:

- Column:  $\beta$ -basic Hypercil (21x100 mm) 5 $\mu$ m  
Solvent A: Water / 0.1% Ammonium carbonate  
Solvent B: Acetonitrile  
30 Flow rate: 25 ml / min  
Run time: 10 minutes with a 7.5 minute gradient from 0-100% B  
Wavelength: 254 nm, bandwidth 10 nm  
Injection volume 1 - 1.5 ml

Mass detector : Micromass ZMD

- Gilson preparative HPLC instrument, with retention time (RT) measured in minutes:

Column: 21 mm x 15 cm Phenomenex Luna2 C18

Solvent A: Water + 0.1% trifluoroacetic acid,

5 Solvent B: Acetonitrile + 0.1% trifluoroacetic acid

Flow rate: 21 ml / min

Run time: 20 minutes with various 10 minute gradients from 5-100% B

Wavelength: 254 nm, bandwidth 10 nm

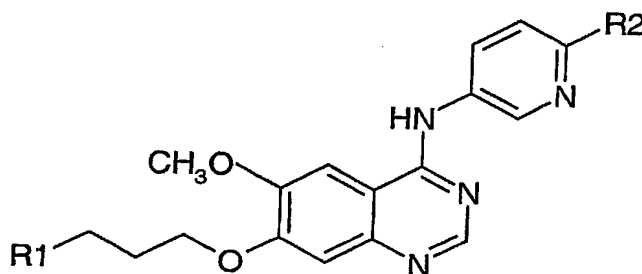
Injection volume 0.1-4.0 ml

10 (x) intermediates were not generally fully characterised and purity was assessed by thin layer chromatography (TLC), HPLC, infra-red (IR), MS or NMR analysis.

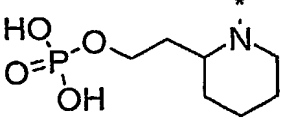
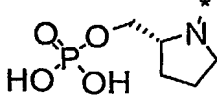
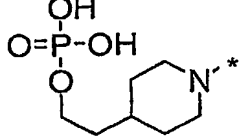
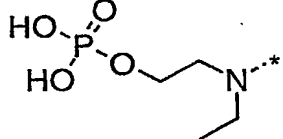
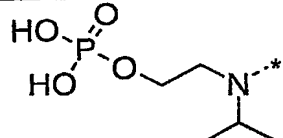
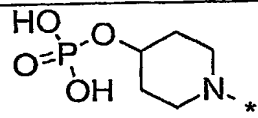
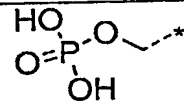
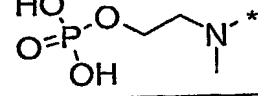
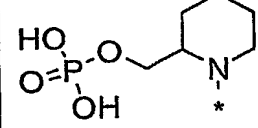
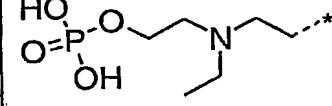
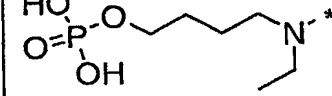
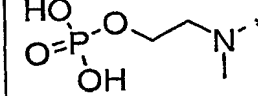
Particular examples of compounds of formula (I) are set out in Tables 1, 2 and 3:

15

TABLE 1

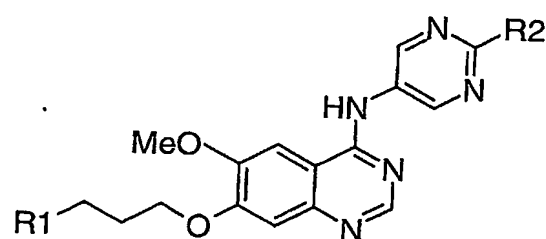


Compound	R1	R2
1		OCH <sub>2</sub> -(3-chlorophenyl)
2		NH-CO-(3-chlorophenyl)
3		NH-CO-(3-chlorophenyl)

4		NH-CO-(3-chlorophenyl)
5		NH-CO-(3-chlorophenyl)
6		NH-CO-(3-chlorophenyl)
7		NH-CO-(3-fluorophenyl)
8		NH-CO-(3,4-difluorophenyl)
9		NH-CO-(3-chlorophenyl)
10		NH-CO-(3-chlorophenyl)
11		NH-CO-(3-chlorophenyl)
12		NH-CO-(3-chlorophenyl)
13		NH-CO-(3-chlorophenyl)
14		NH-CO-(3-chlorophenyl)
15		NH-CO-(3-fluorophenyl)

-35-

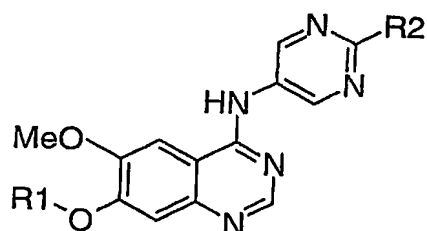
TABLE 2

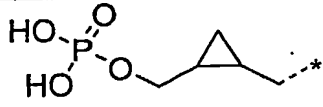
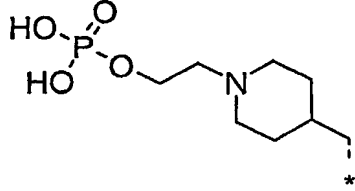


5

	R1	R2
16		NH-CO-(3-chloro,4-fluorophenyl)
17		NH-CO-(3-chloro-4-fluorophenyl)
18		NH-CO-(3-chlorophenyl)
19		CH2NH-(3-chloro-4-fluorophenyl)
20		OCH2-(3-chloro-4-fluorophenyl)

TABLE 3



Compound	R1	R2
21		NH-CO-(3-chloro-4-fluorophenyl)
22		NH-CO-(3-chloro-4-fluorophenyl)

**Example 1 - Preparation of Compound 1 in Table 1 - 3-[(3-[[4-((6-[(3-**

**5 chlorobenzyl)oxy]pyridin-3-yl]amino)-6-methoxyquinazolin-7-yl]oxy]propyl)amino]-3-methylbutyl dihydrogen phosphate**

3-[(3-[[4-((6-[(3-chlorobenzyl)oxy]pyridin-3-yl]amino)-6-methoxyquinazolin-7-yl]oxy]propyl)amino]-3-methylbutan-1-ol (1.7 g, 3.1 mmol) and dry 1*H*-tetrazole (647 mg, 9.23 mmol) were dissolved with heating (50 °C) in dry dimethylacetamide (8 ml) under a nitrogen atmosphere. Di-*tert*-butyl-*N,N*-diethylphosphoramidite (1.2 ml, 4.3 mmol) was added dropwise to the reaction mixture and left to stir at ambient temperature for 20 hours. The reaction mixture was diluted with dichloromethane (160 ml) and washed with aqueous sodium bicarbonate solution (50 ml of a saturated solution). The aqueous layer was further extracted with dichloromethane (150 ml) and the combined organic layers were dried (sodium sulphate), filtered and concentrated under reduced pressure to yield di-*tert*-butyl 3-[(3-[[4-((6-[(3-chlorobenzyl)oxy]pyridin-3-yl]amino)-6-methoxyquinazolin-7-yl]oxy]propyl)amino]-3-methylbutyl phosphite as a viscous, yellow oil. This was dissolved in tetrahydrofuran (10 ml) and hydrogen peroxide (680 µl of a 30 % w/w aqueous solution, ~ 8.8 N, 6.00 mmol) was added slowly at 0 °C. The reaction was warmed to ambient temperature over 10 minutes. The resulting homogeneous solution was stirred for 2 hours then cooled to 0 °C and a solution of sodium metabisulphite (11.5 ml of a 0.53 N aqueous solution) was introduced dropwise. The reaction was warmed to ambient temperature over 15 minutes then diluted with ethyl acetate (100 ml). Aqueous sodium bicarbonate solution (100 ml of a saturated aqueous solution) was added, the phases separated and the aqueous layer further extracted with ethyl acetate (3 x 100 ml). The combined organic layers were dried (sodium

sulphate), filtered and concentrated under reduced pressure to yield di-*tert*-butyl 3-[(3-{[4-({6-[(3-chlorobenzyl)oxy]pyridin-3-yl}amino)-6-methoxyquinazolin-7-yl]oxy}propyl)amino]-3-methylbutyl phosphate as a viscous, yellow oil (1.97 g), which was used in the next step of the reaction sequence without further purification.

5  $^{31}\text{P}$ -NMR  $\{^1\text{H}\}(\text{CDCl}_3)$ : -8.73 (s, 1P) :

MS (+ve ESI): 744 (M+H)<sup>+</sup>.

Hydrogen chloride (4.30 ml of a 4.0 N solution in 1,4-dioxane, 17.2 mmol) was added, dropwise to a solution of the crude phosphate ester (1.97 g) in 1,4-dioxane (86 ml) upon which a white solid precipitated from the reaction mixture. The resulting heterogeneous  
10 reaction mixture was stirred for a further 19 hours and diethyl ether was added (100 ml). The precipitate was filtered and washed with diethyl ether (3 x 30 ml) then dried under high vacuum for 48 hours to yield the title compound, 3-[(3-{[4-({6-[(3-chlorobenzyl)oxy]pyridin-3-yl}amino)-6-methoxyquinazolin-7-yl]oxy}propyl)amino]-3-methylbutyl dihydrogen phosphate (di-hydrochloride salt) as an off-white solid (1.7 g, 91 % yield) :

15  $^1\text{H}$ -NMR (DMSO- $d_6$ ): 11.86 (s, 1H), 9.12 (br s, 2H), 8.81 (s, 1H), 8.53 (s, 1H), 8.50 (d, 1H), 8.08 (dd, 1H), 7.54 (br s, 1H), 7.46-7.39 (m, 4H), 7.05 (d, 1H), 5.41 (s, 2H), 4.34 (t, 2H), 4.05 (s, 3H), 3.98 (dd, 2H), 3.11 (br s, 2H), 2.30 (m, 2H), 2.05 (t, 2H), 1.36 (s, 6H) :

$^{31}\text{P}$ -NMR  $\{^1\text{H}\}(\text{DMSO}-d_6)$ : -0.05 (s, 1P) :

MS (-ve ESI): 630 (M-H)<sup>-</sup>,

20 MS (+ve ESI): 632 (M+H)<sup>+</sup>.

3-[(3-{[4-({6-[(3-chlorobenzyl)oxy]pyridin-3-yl}amino)-6-methoxyquinazolin-7-yl]oxy}propyl)amino]-3-methylbutan-1-ol, used as the starting material, was obtained as follows:

a) A mixture of 2-amino-4-benzyloxy-5-methoxybenzamide (10 g, 0.04 mol), (prepared  
25 according to *J. Med. Chem.* 1977, 20, 146-149), and Gold's reagent (7.4 g, 0.05 mol) in dioxane (100 ml) was stirred and heated at reflux for 24 hours. Sodium acetate (3.02 g, 0.04 mol) and acetic acid (1.65 ml, 0.03 mol) were added to the reaction mixture and it was heated for a further 3 hours. The volatiles were removed by evaporation and water was added to the residue. The solid was collected by filtration, washed with water and dried. Recrystallisation  
30 from acetic acid yielded 7-(benzyloxy)-6-methoxyquinazolin-4(3H)-one (8.7 g, 84 % yield) as a white solid.

b) Chloromethyl pivalate (225ml, 1.56 mol) was added dropwise to a stirred mixture of 7-(benzyloxy)-6-methoxyquinazolin-4(3H)-one (400 g, 1.42 mol) and potassium carbonate

(783 g, 5.67 mol) in dimethylacetamide (5500 ml). The reaction was heated to 90 °C for 4 hours. The reaction was cooled and filtered to remove inorganic salts. The filtrate was concentrated *in vacuo* to yield, crude [7-(benzyloxy)-6-methoxy-4-oxoquinazolin-3(4*H*)-yl]methyl pivalate (562 g, 100 % yield) :

5 <sup>1</sup>H-NMR (DMSO-*d*<sub>6</sub>) : 8.33 (s, 1H), 7.30-7.50 (m, 6H), 7.25 (s, 1H), 5.90 (s, 2H), 5.25 (s, 2H), 3.88 (s, 3H), 1.10 (s, 9H) :

MS (+ve ESI): 397 (M+H)<sup>+</sup>.

c) 10 % palladium on carbon (56 g, 53 mmol) was added to a solution of [7-(benzyloxy)-6-methoxy-4-oxoquinazolin-3(4*H*)-yl]methyl pivalate (562 g, 1.42 mmol) in  
10 dimethylacetamide (3500 ml) at ambient temperature and stirred for 3 hours under an atmosphere of hydrogen (1 bar). The reaction was filtered through a pad of celite and the solvent evaporated *in vacuo*. The residual solid was dissolved in 20 % methanol in dichloromethane and passed through a pad of silica gel. Evaporation of the solvent *in vacuo* followed by trituration with methanol yielded, (7-hydroxy-6-methoxy-4-oxoquinazolin-  
15 3(4*H*)-yl)methyl pivalate (188 g, 43 % yield) :

<sup>1</sup>H-NMR (DMSO-*d*<sub>6</sub>) : 8.25 (s, 1H), 7.45 (s, 1H), 6.97 (s, 1H), 5.85 (s, 2H), 4.04 (s, 1H), 3.87 (s, 3H), 1.10 (s, 9H) :

MS (+ve ESI): 307 (M+H)<sup>+</sup>.

d) A mixture of (7-hydroxy-6-methoxy-4-oxoquinazolin-3(4*H*)-yl)methyl pivalate (100  
20 g, 0.33 mol), 3-bromopropanol (49.3 g, 0.35 mol) and potassium carbonate (133 g, 0.96 mol) in dimethylformamide (500 ml) was stirred at 80 °C for 20 hours. The reaction was cooled and concentrated to quarter volume *in vacuo*. The residue was poured into ice/water (1500 ml) and the resulting solid collected by suction filtration. Purification by crystallisation from ethanol, yielded 7-(3-hydroxypropoxy)-6-methoxy-4-oxoquinazolin-3(4*H*)-yl methyl pivalate  
25 (33.8 g, 41 % yield) as a beige solid :

<sup>1</sup>H-NMR (DMSO-*d*<sub>6</sub>) : 7.95 (s, 1H), 7.43 (s, 1H), 7.10 (s, 1H), 4.16 (t, 2H), 3.86 (m, 5H), 2.08 (t, 2H), 1.12 (s, 9H) :

MS (+ve ESI): 365 (M+H)<sup>+</sup>.

e) An aqueous sodium hydroxide solution (100 ml, 0.20 mol) was added to a solution of  
30 yielded 7-(3-hydroxypropoxy)-6-methoxy-4-oxoquinazolin-3(4*H*)-yl methyl pivalate (33.8 g, 93.0 mmol) in methanol (300 ml) and the solution heated to reflux for 1 hour. The methanol was evaporated *in vacuo*, the residue was acidified with aqueous hydrochloric acid, sodium bicarbonate was added and the solid was collected by suction filtration. Washing with water



and drying yielded 7-(3-hydroxypropoxy)-6-methoxyquinazolin-4(3H)-one (26 g, 95 % yield):

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>) : 7.96 (s, 1H), 7.41 (s, 1H), 7.07 (s, 1H), 4.14 (t, 2H), 3.84 (s, 3H), 3.55 (t, 2H), 1.90 (t, 2H) :

5 MS (+ve ESI): 251 (M+H)<sup>+</sup>.

f) 7-(3-hydroxypropoxy)-6-methoxyquinazolin-4(3H)-one (25.0 g, 100 mmol) was added slowly to a solution of dimethylformamide (1 ml) in thionyl chloride (250 ml). The mixture was heated to reflux for 4 hours then cooled and the solvents evaporated *in vacuo*. The residue was dissolved in dichloromethane and washed with aqueous sodium bicarbonate, 10 brine, dried over magnesium sulphate and evaporated. Trituration and collection of the solid by suction filtration yielded 4-chloro-7-(3-chloropropoxy)-6-methoxyquinazoline (19.5 g, 68 % yield) as a yellow solid :

<sup>1</sup>H-NMR (CDCl<sub>3</sub>) : 8.85 (s, 1H), 7.40 (s, 1H), 7.38 (s, 1H), 4.38 (t, 2H), 4.03 (s, 3H), 3.8 (t, 2H), 2.40 (m, 2H) :

15 MS (+ve ESI): 287 (M+H)<sup>+</sup>.

g) 4-chloro-7-(3-chloropropoxy)-6-methoxyquinazoline (574 mg, 2.00 mmol) and 5-amino-2-(3-chlorobenzoyloxy)pyridine (468 mg, 2.0 mmol, see-patent WO 0121597) were heated in dimethylacetamide (10 ml) at 100 °C for 4 hours. The reaction was cooled to ambient temperature and the solid collected by suction filtration and washed with diethyl 20 ether (25 ml) and acetone (5 ml). Drying *in vacuo* yielded *N*-{6-[(3-chlorobenzyl)oxy]pyridin-3-yl}-7-(3-chloropropoxy)-6-methoxyquinazolin-4-amine (640 mg, 66 % yield) as a white solid :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>) : 11.60 (s, 1H), 8.78 (s, 1H), 8.46 (s, 1H), 8.37 (s, 1H), 8.04 (dd, 1H), 7.52 (s, 1H), 7.39 (s, 1H), 7.03 (d, 1H), 5.39 (s, 2H), 4.29 (t, 2H), 4.01 (s, 3H), 3.82 (t, 2H), 25 2.29 (m, 2H) :

MS (+ve ESI): 485.5 (M+H)<sup>+</sup>.

h) *N*-{6-[(3-chlorobenzyl)oxy]pyridin-3-yl}-7-(3-chloropropoxy)-6-methoxyquinazolin-4-amine (1.83 g, 3.77 mmol), 3-amino-3-methylbutanol (1.94 g, 18.9 mmol) and potassium iodide (62 mg, 0.38 mmol) in dimethylacetamide (10 ml) was heated at 90 °C for 16 hours. 30 The mixture was cooled, poured into 2.0 N aqueous ammonia (150 ml) and the supernatant decanted off and extracted with ethyl acetate (2 x 50ml). The insoluble gum was dissolved in dichloromethane/methanol mixture, combined with the ethyl acetate fraction and evaporated *in vacuo*. Purification by flash chromatography on silica gel, eluting with dichloromethane :

methanol : aqueous ammonia (100:5:0.3 to 100:25:2) yielded 3-[(3-{[4-{(6-{(3-chlorobenzyl)oxy}pyridin-3-yl)amino)-6-methoxyquinazolin-7-yl]oxy}propyl)amino]-3-methylbutan-1-ol (1.56 g, 75 % yield) as an off-white solid :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 9.52 (s, 1H), 8.40 (m, 2H), 8.09 (dd, 1H), 7.80 (s, 1H), 7.53 (s, 1H),  
 5 7.41 (m, 3H), 7.18 (s, 1H), 6.97 (d, 1H), 5.38 (s, 2H), 4.19 (t, 1H), 3.96 (s, 3H), 3.52 (t, 2H),  
 2.64 (t, 2H), 1.88 (t, 2H), 1.51 (t, 2H), 1.03 (s, 6H) :

MS (-ve ESI): 550.7 (M-H)<sup>-</sup>,

MS (+ve ESI): 552.7 (M+H)<sup>+</sup>.

10 **Example 2 - Preparation of Compound 2 in Table 1 - 3-[(3-{[4-{(6-{(3-chlorobenzoyl)amino}pyridin-3-yl)amino)-6-methoxyquinazolin-7-yl]oxy}propyl)amino]-3-methylbutyl dihydrogen phosphate**

Di-*tert*-butyl-*N,N*-diethylphosphoramidite (660 mg, 2.65 mmol) was added slowly to a mixture of 3-chloro-*N*-{5-[(7-{3-[(3-hydroxy-1,1-dimethylpropyl)amino]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl}benzamide (742 mg, 1.31 mmol) and 1*H*-  
 15 tetrazole (273 mg, 3.9 mmol) in dimethylacetamide (1.7 ml). The reaction was stirred under an inert atmosphere at ambient temperature for 24 hours during which a further portion of di-*tert*-butyl-*N,N*-diethylphosphoramidite (330 mg, 1.32 mmol) was added. Dichloromethane (34 ml), methanol (1.7 ml) and 20 % aqueous potassium hydrogen carbonate solution (5 ml) were  
 20 added and the reaction mixture stirred briefly. The aqueous layer was removed by filtration through a Varian CE1020 Chem Elut Hydromatrix cartridge. Solvent evaporation *in vacuo* gave a yellow oil which was taken up in tetrahydrofuran (2 ml), cooled to 0 °C and treated with 30 % aqueous hydrogen peroxide (0.4 ml, 3.9 mmol). The mixture was allowed to warm to ambient temperature and stirred for 2 hours. The reaction was cooled to 0 °C, quenched  
 25 with aqueous sodium metabisulphite, treated with 20 % aqueous potassium hydrogen carbonate and extracted into 10:1 dichloromethane : methanol (4 x 10 ml). Solvent evaporation *in vacuo* gave a yellow oil, which was taken up in dioxane (40 ml) and treated dropwise with a 4.0 N solution of hydrogen chloride in dioxane (1.96 ml, 7.86 mmol). The white slurry was stirred at ambient temperature for 18 hours, diluted with an equal volume of  
 30 dichloromethane and the solution absorbed onto flash silica. Purification by flash chromatography, eluting with dichloromethane : methanol: formic acid : water (100:20:3:3 to 100:40:10:10), yielded the title compound (as the trihydrochloride salt, 380 mg, 38 % yield) as a pale yellow solid :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub> + CD<sub>3</sub>COOD): 8.80 (s, 1H), 8.73 (d, 1H), 8.30 (m, 2H), 8.19 (dd, 1H), 8.04 (m, 1H), 7.96 (d, 1H), 7.60 (m, 1H), 7.50 (t, 1H), 7.39 (s, 1H), 4.31 (t, 2H), 4.02 (m, 5H), 3.11 (t, 2H), 2.27 (m, 2H), 2.04 (m, 2H), 1.35 (s, 6H) :

<sup>31</sup>P-NMR (DMSO-d<sub>6</sub> + CD<sub>3</sub>COOD): 0.08 (s, 1P):

5 MS (+ve ESI): 645.7, 647.7 (M+H)<sup>+</sup>.

3-chloro-*N*-{5-[(7-{3-[(3-hydroxy-1,1-dimethylpropyl)amino]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl}benzamide, used as the starting material, was obtained as follows:

a) 3-chlorobenzoyl chloride (22.1 g, 127 mmol) was added dropwise to a stirred solution of 2-amino-5-nitropyridine (16.0 g, 115 mmol) in pyridine (240 ml) and heated to 100 °C for 16 hours. The solution was evaporated *in vacuo*, the resulting solid was taken-up in dichloromethane (200 ml) and eluted through silica gel (800 g), with dichloromethane. The relevant fractions were combined and concentrated under reduced pressure to yield 3-chloro-*N*-(5-nitropyridin-2-yl)benzamide (31.6 g, 99 % yield) as an off-white solid :

15 <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 11.64 (s, 1H), 9.20 (d, 1H), 8.63 (dd, 1H), 8.40 (d, 1H), 8.06 (s, 1H), 7.98 (d, 1H), 7.69 (d, 1H), 7.55 (dd, 1H) :

MS (-ve ESI) 276 (M-H)<sup>-</sup>,

MS (+ve ESI): 278 (M+H)<sup>+</sup>.

b) 3-Chloro-*N*-(5-nitropyridin-2-yl)benzamide (31.5 g, 113 mmol) and 10 % platinum on carbon (3.6 g) in dichloromethane was stirred under a hydrogen atmosphere (1 bar pressure) for 18 hours. The suspension was filtered through Celite®, the filter cake was washed with ethyl acetate : ethanol (10:1, 1400 ml) and the filtrate concentrated under reduced pressure to yield *N*-(5-aminopyridin-2-yl)-3-chlorobenzamide (26.3 g, 94 % yield) as an off-white powdery solid :

25 <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 10.50 (s, 1H), 8.03 (s, 1H), 7.96 (d, 1H), 7.80 (d, 1H), 7.76 (d, 1H), 7.61 (d, 1H), 7.52 (dd, 1H), 7.04 (dd, 1H), 5.22 (s, 2H) :

MS (-ve ESI): 246 (M-H)<sup>-</sup>,

MS (+ve ESI): 248 (M+H)<sup>+</sup>.

c) 4-chloro-7-(3-chloropropoxy)-6-methoxyquinazoline (2.87 g, 10.0 mmol) and *N*-(5-aminopyridin-2-yl)-3-chlorobenzamide (2.54 g, 10.0 mmol) were suspended in dry dimethylacetamide (100 ml) under a nitrogen atmosphere and warmed to 50 °C. Hydrogen chloride (2.5 ml of a 4.0 N solution in 1,4-dioxane, 10 mmol) was added dropwise, causing precipitation of a yellow solid from the reaction mixture. The resulting heterogeneous reaction

mixture was stirred for 4.5 hours at 80 °C then cooled to ambient temperature. Diethyl ether (200 ml) was added and the solid collected by suction filtration to yield 3-chloro-*N*-(5-{[7-(3-chloropropoxy)-6-methoxyquinazolin-4-yl]amino}pyridin-2-yl)benzamide hydrochloride as a pale yellow solid (4.83 g, 90 % yield) :

- 5 <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 11.64 (br s, 1H), 11.04 (br s, 1H), 8.83 (s, 1H), 8.75 (d, 1H), 8.39 (s, 1H), 8.25 (d, 1H), 8.18 (dd, 1H), 8.08 (s, 1H), 7.97 (d, 1H), 7.65 (d, 1H), 7.55 (t, 1H), 7.39 (s, 1H), 4.30 (t, 2H), 4.03 (s, 3H), 3.82 (t, 2H), 2.29 (m, 2H) :

MS (-ve ESI): 496.3 (M-H)<sup>-</sup>,

MS (+ve ESI): 498.3 (M+H)<sup>+</sup>.

- 10 d) 3-chloro-*N*-(5-{[7-(3-chloropropoxy)-6-methoxyquinazolin-4-yl]amino}pyridin-2-yl)benzamide hydrochloride (1.07 g, 2.00 mmol), 3-amino-3-methylbutanol (1.03 g, 10.0 mmol) and potassium iodide (32 mg, 0.2 mmol) in dimethylacetamide (2.5 ml) was heated at 80 °C for 4 days. The mixture was cooled, diluted with dichloromethane (25 ml) and the solution absorbed onto silica gel. Purification by flash chromatography, eluting with
- 15 dichloromethane : methanol : aqueous ammonia (100:5:0.5 to 100:25:2), yielded 3-chloro-*N*-(5-{[7-(3-{[3-(3-hydroxy-1,1-dimethylpropyl)amino]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl}benzamide as a pale yellow solid (804 mg, 71 % yield) :

- <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 10.92 (br s, 1H), 9.68 (s, 1H), 8.80 (s, 1H), 8.48 (s, 1H), 8.29 (d, 1H), 8.19 (d, 1H), 8.08 (s, 1H), 8.00 (d, 1H), 7.88 (s, 1H), 7.66 (d, 1H), 7.55 (dd, 1H), 7.20 (s, 1H),
- 20 4.20 (t, 2H), 3.97 (s, 3H), 3.50 (m, 2H), 2.74 (t, 2H), 1.94 (m, 2H), 1.57 (m, 2H), 1.07 (s, 6H)

MS (-ve ESI): 563 (M-H)<sup>-</sup>,

MS (+ve ESI): 565 (M+H)<sup>+</sup>.

25 **Example 3 - Preparation of Compound 3 in Table 1 - 2-[(3-{[4-{[6-{[3-chlorobenzoyl]amino]pyridin-3-yl}amino)-6-methoxyquinazolin-7-yl]oxy}propyl)(ethyl)amino]ethyl dihydrogen phosphate**

- An analogous reaction to that described in example 2, but starting with 3-chloro-*N*-(5-{[7-(3-{[ethyl(2-hydroxyethyl)amino]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl}benzamide (244 mg, 0.443 mmol), yielded the title compound (as the trihydrochloride salt,
- 30 174 mg, 53 % yield) as a pale yellow solid :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub> + CD<sub>3</sub>COOD): 8.79 (s, 1H), 8.71 (d, 1H), 8.31 (d, 1H), 8.16 (dd, 1H), 8.08 (s, 2H), 8.00 (d, 1H), 7.63 (m, 1H), 7.53 (m, 2H), 4.41 (t, 2H), 4.20 (m, 2H), 4.02 (s, 3H), 3.41 (m, 2H), 3.32 (t, 2H), 3.26 (q, 2H), 2.24 (m, 2H), 1.28 (t, 3H) :

MS (+ve ESI): 631.6 and 633.6 (M+H)<sup>+</sup>.

3-chloro-*N*-{5-[(7-{3-[ethyl(2-hydroxyethyl)amino]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl}benzamide, used as the starting material, was obtained as described in example 2d but starting with 2-(ethylamino)ethanol (334 mg, 3.75 mmol). The reaction

5 yielded 3-chloro-*N*-{5-[(7-{3-[ethyl(2-hydroxyethyl)amino]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl}benzamide (304 mg, 74 % yield) as a pale yellow solid :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 9.59 (s, 1H), 8.77 (d, 1H), 8.45 (s, 1H), 8.26 (dd, 1H), 8.18 (d, 1H), 8.07 (t, 1H), 7.98 (d, 1H), 7.81 (s, 1H), 7.65 (m, 1H), 7.54 (t, 1H), 7.18 (s, 1H), 4.26 (t, 1H), 4.17 (t, 2H), 3.96 (s, 3H), 3.42 (q, 2H), 2.58 (t, 2H), 2.50 (m, 4H), 1.98 (m, 2H), 0.95 (t, 3H) :

10 MS (-ve ESI): 549.6 (M-H)<sup>-</sup>,

MS (+ve ESI): 551.5 (M+H)<sup>+</sup>.

**Example 4 - Preparation of Compound 4 in Table 1 - 2-[1-(3-{[4-({6-[(3-chlorobenzoyl)amino]pyridin-3-yl)amino]-6-methoxyquinazolin-7**

15 **yl]oxy}propyl)piperidin-2-yl]ethyl dihydrogen phosphate**

An analogous reaction to that described in example 2, but starting with 3-chloro-*N*-{5-[(7-{3-[2-(2-hydroxyethyl)piperidin-1-yl]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl}benzamide (286 mg, 0.48 mmol), yielded the title compound (as the trihydrochloride salt, 114 mg, 31 % yield) as a pale yellow solid :

20 <sup>1</sup>H-NMR (DMSO-d<sub>6</sub> + CD<sub>3</sub>COOD): 8.92 (s, 1H), 8.71 (d, 1H), 8.31 (d, 1H), 8.17 (m, 1H), 8.09 (s, 1H), 7.98 (d, 1H), 7.63 (m, 1H), 7.52 (m, 1H), 7.36 (s, 1H), 4.32 (t, 2H), 4.03 (s, 3H), 3.96 (m, 2H), 3.30 (m, 5H), 2.30 (m, 2H), 1.95 (m, 4H), 1.74 (m, 4H), 1.52 (m, 2H) :

MS (+ve ESI): 671.7 and 673.7 (M+H)<sup>+</sup>.

3-chloro-*N*-{5-[(7-{3-[2-(2-hydroxyethyl)piperidin-1-yl]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl}benzamide, used as the starting material, was obtained as described in example 2d but starting with 2-(hydroxyethyl)piperidine (1.29 g, 10.0 mmol). The reaction

25 yielded 3-chloro-*N*-{5-[(7-{3-[2-(2-hydroxyethyl)piperidin-1-yl]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl}benzamide (913 mg, 77 % yield) as a pale yellow solid :

30 <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 10.91 (s, 1H), 9.72 (br s, 1H), 8.81 (d, 1H), 8.46 (s, 1H), 8.29 (dd, 1H), 8.20 (d, 1H), 8.10 (t, 1H), 8.00 (d, 1H), 7.91 (s, 1H), 7.65 (m, 1H), 7.55 (t, 1H), 7.20 (s, 1H), 4.20 (t, 2H), 3.99 (s, 3H), 3.50 (m, 2H), 3.00 (m, 2H), 2.80 (m, 2H), 2.60 (m, 1H), 2.03 (m, 2H), 1.93 (m, 1H), 1.72 (m, 1H), 1.57 (m, 4H), 1.39 (m, 2H) :

MS (-ve ESI): 589.6 (M-H)<sup>-</sup>,

MS (+ve ESI): 591.5 (M+H)<sup>+</sup>.

**Example 5 - Preparation of Compound 5 in Table 1 - [(2R)-1-(3-{[4-{(3-**

**5 chlorobenzoyl)amino]pyridin-3-yl}amino)-6-methoxyquinazolin-7-ylloxy}propyl)pyrrolidin-2-yl)methyl dihydrogen phosphate**

An analogous reaction to that described in example 2, but starting with 3-chloro-*N*-(5-[(7-{3-[(2*R*)-2-(hydroxymethyl)pyrrolidin-1-yl]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl)benzamide (78 mg, 0.139 mmol), yielded the title compound (as the trihydrochloride salt, 49 mg, 47 % yield) as a pale yellow solid :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub> + CD<sub>3</sub>COOD): 8.85 (s, 1H), 8.74 (m, 1H), 8.32 (d, 1H), 8.21 (m, 2H), 8.09 (s, 2H), 7.99 (d, 1H), 7.66 (m, 1H), 7.55 (t, 1H), 7.44 (s, 1H), 4.35 (m, 2H), 4.21 (m, 1H), 4.12 (m, 1H), 4.04 (s, 3H), 3.80 (m, 1H), 3.65 (m, 1H), 3.50 (m, 1H), 3.28 (m, 2H), 2.32 (m, 2H), 2.19 (m, 1H), 1.95 (m, 3H) :

MS (+ve ESI): 643.6, 645.6 (M+H)<sup>+</sup>.

3-chloro-*N*-(5-[(7-{3-[(2*R*)-2-(hydroxymethyl)pyrrolidin-1-yl]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl)benzamide used as the starting material was obtained as follows:

A mixture of 3-chloro-*N*-(5-{[7-(3-chloropropoxy)-6-methoxyquinazolin-4-yl]amino}pyridin-2-yl)benzamide (100 mg, 0.20 mmol), (2*R*)-pyrrolidin-2-ylmethanol (102 mg, 1.00 mmol) and tetra-*n*-butylammonium iodide (7.5 mg, 0.02 mmol) in dimethylacetamide (1 ml) was heated at 60 °C for 17 hours. The mixture was cooled and diluted with dichloromethane (10 ml) and purified by flash chromatography on silica gel, eluting with dichloromethane : methanol : 7.0 N ammonia in methanol (9:1:0 to 9:1:0.8) yielded 3-chloro-*N*-(5-[(7-{3-[(2*R*)-2-(hydroxymethyl)pyrrolidin-1-yl]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl)benzamide (107 mg, 95 % yield) as a yellow solid :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 10.96 (s, 1H), 9.76 (s, 1H), 8.82 (d, 1H), 8.48 (s, 1H), 8.30 (dd, 1H), 8.21 (d, 1H), 8.10 (s, 1H), 8.00 (d, 1H), 7.94 (s, 1H), 7.67 (d, 1H), 7.55 (dd, 1H), 7.21 (s, 1H), 4.20 (t, 2H), 3.98 (s, 3H), 3.48 (m, 2H), 2.73 (m, 2H), 1.55-2.15 (m, 7H) :

MS (-ve ESI): 561.5 (M-H)<sup>-</sup>,

MS (+ve ESI): 563.6 (M+H)<sup>+</sup>.

**Example 6 - Preparation of Compound 6 in Table 1 - 2-[1-(3-{[4-({6-[3-chlorobenzoyl]amino]pyridin-3-yl}amino)-6-methoxyquinazolin-7-yl]oxy}propyl)piperidin-4-yl]ethyl dihydrogen phosphate**

An analogous reaction to that described in example 2, but starting with 3-chloro-*N*-{5-[(7-{3-[4-(2-hydroxyethyl)piperidin-1-yl]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl}benzamide (200 mg, 0.34 mmol), yielded the title compound (as the trihydrochloride salt, 137 mg, 45 % yield) as a pale yellow solid :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub> + CD<sub>3</sub>COOD): 8.82 (s, 1H), 8.75 (d, 1H), 8.35 (s, 1H), 8.27 (m, 2H), 8.06 (s, 1H), 7.98 (d, 1H), 7.62 (m, 1H), 7.50 (m, 1H), 7.37 (s, 1H), 4.29 (m, 2H), 4.02 (s, 3H), 3.90 (q, 2H), 3.53 (d, 2H), 3.22 (m, 3H), 2.93 (t, 2H), 2.31 (m, 2H), 1.90 (m, 2H), 1.70 (m, 1H), 1.55 (m, 3H) :

MS (+ve ESI): 671.7, 673.7 (M+H)<sup>+</sup>.

3-chloro-*N*-{5-[(7-{3-[4-(2-hydroxyethyl)piperidin-1-yl]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl}benzamide used as the starting material, was obtained as described in example 2d but starting with 2-(piperidin-4-yl)ethanol (1.73 ml, 20.0 mmol). The reaction yielded 3-chloro-*N*-{5-[(7-{3-[4-(2-hydroxyethyl)piperidin-1-yl]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl}benzamide (1.4 g, 59 % yield) as a yellow solid.

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 10.96 (br s, 1H), 9.61 (s, 1H), 8.79 (br s, 1H), 8.48 (s, 1H), 8.30 (m, 1H), 8.21 (d, 1H), 8.10 (s, 1H), 8.00 (d, 1H), 7.84 (s, 1H), 7.64 (d, 1H), 7.58 (m, 1H), 7.21 (s, 1H), 4.30 (m, 2H), 4.19 (m, 2H), 3.98 (s, 3H), 3.48 (m, 2H), 2.73 (m, 2H), 2.41 (m, 2H), 1.98-1.80 (m, 3H), 1.60 (d, 2H), 1.45 (br s, 2H), 1.05-1.20 (m, 2H):

MS (-ve ESI): 589.5 (M-H)<sup>-</sup>,

MS (+ve ESI): 591.5 (M+H)<sup>+</sup>.

**Example 7 - Preparation of Compound 7 in Table 1 - 2-[ethyl(3-{[4-({6-[3-fluorobenzoyl]amino]pyridin-3-yl}amino)-6-methoxyquinazolin-7-yl]oxy}propyl)amino]ethyl dihydrogen phosphate**

Di-*tert*-butyl-*N,N*-diethylphosphoramidite (630 mg, 2.52 mmol) was added to a mixture of 3-fluoro-*N*-{5-[(7-{3-[ethyl(2-hydroxyethyl)amino]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl}-benzamide (673 mg, 1.26 mmol) and dry 1 *H*-tetrazole (176 mg, 2.52 mmol) in dimethylacetamide (10 ml). The reaction was stirred under an inert atmosphere at ambient temperature for 160 minutes. Dichloromethane (100 ml) and 20 % aqueous potassium hydrogen carbonate solution (5 ml) were added and the reaction

mixture stirred briefly. The aqueous layer was removed by filtration through a Varian CE1020 Chem Elut Hydromatrix cartridge and the organic fraction was evaporated *in vacuo* to give a yellow oil which was taken up in tetrahydrofuran (5 ml). The solution was cooled to -5 °C, 30 % aqueous hydrogen peroxide (0.21 ml, 1.89 mmol) was added slowly and the reaction was stirred at 0 °C for 1 hour. The reaction was washed with aqueous sodium metabisulphite and 20 % aqueous potassium hydrogen carbonate solution and extracted into dichloromethane. Solvent evaporation *in vacuo* gave a yellow oil which was purified by chromatography on silica gel, eluting with dichloromethane : methanol : concentrated aqueous ammonia (200:16:1) to yield a pale yellow oil. This was taken up in dioxane (20 ml) and treated dropwise with a 4.0 N solution of hydrogen chloride in dioxane (1.89 ml, 7.56 mmol). The white slurry was stirred at ambient temperature for 18 hours, diluted with methanol (40 ml) and dichloromethane (40 ml) and the solution absorbed onto flash silica. Purification by flash chromatography, eluting with dichloromethane : methanol : formic acid : water (100:20:3:3 to 100:40:10:10), yielded the title compound (as the trihydrochloride salt, 324 mg, 37 % yield) as a pale yellow solid :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub> + CD<sub>3</sub>COOD): 8.82 (d, 1H), 8.58 (s, 1H), 8.30 (dd, 2H), 8.20 (d, 1H), 7.92 (s, 1H), 7.88 (d, 1H), 7.83 (d, 1H), 7.53 (dd, 1H), 7.39 (m, 1H), 4.24 (t, 2H), 4.08 (m, 2H), 3.99 (s, 3H), 3.26 (m, 6H), 2.24 (m, 2H), 1.25 (t, 3H) :

<sup>31</sup>P-NMR (DMSO-d<sub>6</sub> + CD<sub>3</sub>COOD): 1.68 (s, 1P) :

MS (+ve ESI): 615.5 (M+H)<sup>+</sup> :

3-fluoro-*N*-{5-[(7-{3-[ethyl(2-hydroxyethyl)amino]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl}-benzamide, used as the starting material, was obtained as follows:

a) An analogous reaction to that described in example 2a but starting with 3-fluorobenzoyl chloride (4.95g, 31.2mmol) yielded *N*-(5-nitropyridin-2-yl)-3-fluorobenzamide as a light yellow solid (6.44 g, 88 % yield) :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 11.58 (br s, 1H), 9.21 (s, 1H), 8.64 (dd, 1H), 8.42 (d, 1H), 7.87 (m, 2H), 7.58 (m, 1H), 7.46 (m, 2H) :

MS (-ve ESI): 260 (M-H)<sup>-</sup>,

MS (+ve ESI): 262 (M+H)<sup>+</sup>.

b) An analogous reaction to that described in example 2b but starting with *N*-(5-nitropyridin-2-yl)-3-fluorobenzamide (5.8g, 22.2mmol) yielded *N*-(5-aminopyridin-2-yl)-3-fluorobenzamide as a cream solid (5.0 g, 96 % yield) :



<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 10.38 (br s, 1H), 7.79 (m, 4H), 7.55 (m, 1H), 7.38 (t, 1H), 7.01 (dd, 1H), 5.18 (br s, 2H) :

MS (-ve ESI): 230 (M-H)<sup>-</sup>,

MS (+ve ESI): 232 (M+H)<sup>+</sup>.

- 5 c) An analogous reaction to that described in example 2c but starting with *N*-(5-aminopyridin-2-yl)-3-fluorobenzamide (0.69 g, 3.0 mmol) yielded 3-fluoro-*N*-(5-{[7-(3-chloropropoxy)-6-methoxyquinazolin-4-yl]amino}pyridin-2-yl)benzamide hydrochloride as a pale yellow solid (1.52 g, 98 % yield) :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 11.78 (br s, 1H), 11.02 (br s, 1H), 8.84 (s, 1H), 8.76 (d, 1H), 8.45 (s, 10 1H), 8.21 (m, 2H), 7.86 (m, 2H), 7.55 (m, 1H), 7.43 (m, 2H), 4.28 (t, 2H), 4.03 (s, 3H), 3.81 (t, 2H), 2.28 (m, 2H) :

MS (-ve ESI): 480.0 (M-H)<sup>-</sup>,

MS (+ve ESI): 482.0 (M+H)<sup>+</sup>.

- d) An analogous reaction to that described in example 2d but starting with 3-fluoro-*N*-(5-{[7-(3-chloropropoxy)-6-methoxyquinazolin-4-yl]amino}pyridin-2-yl)benzamide 15 hydrochloride (1.03 g, 2.00 mmol) and 2-(ethylamino)ethanol (0.89 g, 10.0 mmol) yielded 3-fluoro-*N*-(5-{[7-(3-[ethyl(2-hydroxyethyl)amino]propoxy)-6-methoxyquinazolin-4-yl]amino}pyridin-2-yl)-benzamide (667 mg, 62 % yield) as a pale yellow solid :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 9.59 (s, 1H), 8.77 (d, 1H), 8.44 (s, 1H), 8.26 (dd, 1H), 8.19 (d, 1H), 20 7.85 (m, 3H), 7.56 (m, 1H), 7.42 (m, 1H), 7.17 (s, 1H), 4.35 (br s, 1H), 4.18 (t, 2H), 3.96 (s, 3H), 3.44 (q, 2H), 2.44 (m, 6H), 1.91 (m, 2H), 0.97 (t, 3H) :

MS (-ve ESI): 533.6 (M-H)<sup>-</sup>,

MS (+ve ESI): 535.6 (M+H)<sup>+</sup>.

25 **Example 8 - Preparation of Compound 8 in Table 1 -**

**2-[(3-{[4-({6-[(3,4-difluorobenzoyl)amino]pyridin-3-yl)amino}-6-methoxyquinazolin-7-yl]oxy}propyl)(isopropyl)amino]ethyl dihydrogen phosphate**

- An analogous reaction to that described in example 7, but starting with 3,4-difluoro-*N*-(5-{[7-(3-[(2-hydroxyethyl)(isopropyl)amino]propoxy)-6-methoxyquinazolin-4-yl]amino}pyridin-2-yl)benzamide (652 mg, 1.15 mmol), yielded the title compound (as a 30 dihydrochloride salt, 398 mg, 45 % yield) as a pale yellow solid :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub> + CD<sub>3</sub>COOD): 8.76 (m, 2H), 8.29 (s, 1H), 8.22 (m, 2H), 8.10 (m, 1H), 7.92 (m, 1H), 7.66 (s, 1H), 7.54 (dd, 1H), 7.37 (s, 1H), 4.41 (t, 2H), 4.18 (m, 2H), 4.04 (s, 3H), 3.74 (m, 1H), 3.37 (m, 2H), 3.23 (m, 2H), 2.26 (m, 2H), 1.28 (d, 6H) :

MS (+ve ESI): 647.5 (M+H)<sup>+</sup>.

- 5 3,4-difluoro-*N*-{5-[(7-{3-[(2-hydroxyethyl)(isopropyl)amino]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl}benzamide, used as the starting material, was obtained as follows :

a) An analogous reaction to that described in example 2a but starting with 3,4-difluorobenzoyl chloride (19.4 g, 110 mmol) yielded *N*-(5-nitropyridin-2-yl)-3,4-difluorobenzamide (24.9 g, 89 % yield) :

- 10 <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 11.60 (br s, 1H), 9.20 (d, 1H), 8.63 (dd, 1H), 8.38 (d, 1H), 8.11 (m, 1H), 7.92 (m, 1H), 7.59 (d, 1H) :

MS (+ve ESI): 280.3 (M+H)<sup>+</sup>.

b) An analogous reaction to that described in example 2b but starting with *N*-(5-nitropyridin-2-yl)-3,4-difluorobenzamide (24.67 g, 88.4 mmol) yielded *N*-(5-aminopyridin-2-

- 15 yl)-3,4-difluorobenzamide (21 g, 95 % yield) as an off-white powder :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 10.44 (br s, 1H), 8.06 (m, 1H), 7.94 (m, 1H), 7.73 (m, 1H), 7.00 (m, 1H), 5.18 (br s, 2H) :

MS (+ve ESI): 250.3 (M+H)<sup>+</sup>.

c) An analogous reaction to that described in example 2c but starting with *N*-(5-

- 20 aminopyridin-2-yl)-3,4-difluorobenzamide (1.24 g, 5.0 mmol) yielded 3,4-difluoro-*N*-(5-{[7-(3-chloropropoxy)-6-methoxyquinazolin-4-yl]amino}pyridin-2-yl)benzamide hydrochloride as a pale yellow solid (2.56 g, 96.0 % yield) :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 8.84 (s, 1H), 8.75 (d, 1H), 8.43 (s, 1H), 8.20 (m, 2H), 8.10 (m, 1H), 7.93 (m, 1H), 7.59 (m, 1H), 7.41 (m, 1H), 4.28 (t, 2H), 4.03 (s, 3H), 3.81 (t, 2H), 2.27 (m,

- 25 2H):

MS (-ve ESI): 498.5 (M-H)<sup>-</sup>,

MS (+ve ESI): 500.5 (M+H)<sup>+</sup>.

d) An analogous reaction to that described in example 2d but starting with 3,4-difluoro-*N*-(5-{[7-(3-chloropropoxy)-6-methoxyquinazolin-4-yl]amino}pyridin-2-yl)benzamide

- 30 hydrochloride (0.40 g, 0.75 mmol) and 2-(isopropylamino)ethanol (0.39 g, 3.75 mmol) yielded 3,4-difluoro-*N*-{5-[(7-{3-[(2-hydroxyethyl)(isopropyl)amino]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl}benzamide (193 mg, 45 % yield) as a pale yellow solid :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 10.92 (s, 1H), 9.60 (s, 1H), 8.77 (d, 1H), 8.46 (s, 1H), 8.26 (dd, 1H), 8.19 (d, 1H), 8.13 (m, 1H), 7.95 (m, 1H), 7.84 (s, 1H), 7.57 (m, 1H), 7.17 (s, 1H), 4.21 (m, 3H), 3.96 (s, 3H), 3.36 (m, 2H), 2.88 (m, 1H), 2.56 (m, 2H), 2.45 (m, 2H), 1.85 (m, 2H), 0.91 (d, 6H) :

5 MS (-ve ESI): 565.4 (M-H)<sup>-</sup>,

MS (+ve ESI): 567.3 (M+H)<sup>+</sup>.

**Example 9 - Preparation of Compound 9 in Table 1 1-(3-{[4-({6-[(3-chlorobenzoyl)amino]pyridin-3-yl}amino)-6-methoxyquinazolin-7-**

**10 yl]oxy}propyl)piperidin-4-yl dihydrogen phosphate**

3-chloro-*N*-[5-({7-[3-(4-hydroxypiperidin-1-yl)propoxy]-6-methoxyquinazolin-4-yl}amino)pyridin-2-yl]benzamide (281 mg, 0.50 mmol) and dry 1 *H*-tetrazole (157 mg, 2.30 mmol) were dissolved in dry dimethylacetamide (10.6 ml). Di-*tert*-butyl-*N,N*-diethylphosphoramidite (210 µl, 0.74 mmol) was added and the reaction stirred at ambient  
15 temperature for 2 hours. Further portions of 1 *H*-tetrazole (157 mg, 2.3 mmol) and di-*tert*-butyl-*N,N*-diethylphosphoramidite (210 µl, 0.74 mmol) were added and the reaction mixture stirred for 18 hours. The reaction was cooled to -40 °C and 3-chloroperoxybenzoic acid (366 mg, 1.49 mmol) added. The reaction was warmed to ambient temperature, concentrated and  
20 suspended in a solution of sodium metabisulphite (10 ml of a 0.26 M solution). This was extracted with ethyl acetate and the organics washed with sodium bicarbonate (sat. solution), dried magnesium sulphate) and concentrated. Purification by flash chromatography on alumina, eluting with dichloromethane : methanol : saturated ammonia (97:2:1) yielded di-*tert*-butyl 1-(3-{[4-({6-[(3-chlorobenzoyl)amino]pyridin-3-yl}amino)-6-methoxyquinazolin-7-yl]oxy}propyl)piperidin-4-yl phosphate as a yellow solid (210 mg, 56 % yield):  
25 <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 10.91 (s, 1H), 9.59 (s, 1H), 8.77 (d, 1H), 8.45 (s, 1H), 8.26 (dd, 1H), 8.18 (d, 1H), 8.09 (s, 1H), 7.98 (d, 1H), 7.82 (s, 1H), 7.65 (d, 1H), 7.54 (t, 1H), 7.18 (s, 1H), 4.17 (m, 3H), 3.96 (s, 3H), 3.36 (m, 2H), 2.62 (m, 2H), 2.44 (t, 2H), 2.21 (t, 2H), 1.87 (m, 4H), 1.63, (m, 2H), 1.39 (s, 18H).

Hydrogen chloride (150 µl of a 4.0 N solution in 1,4-dioxane, 0.6 mmol) was added,  
30 dropwise to a solution of di-*tert*-butyl 1-(3-{[4-({6-[(3-chlorobenzoyl)amino]pyridin-3-yl}amino)-6-methoxyquinazolin-7-yl]oxy}propyl)piperidin-4-yl phosphate (70 mg, 0.1 mmol) in 1,4-dioxane (3 ml). The resulting heterogeneous reaction mixture was stirred for a further hour and diethyl ether was added (10 ml). The precipitate was filtered and washed

with diethyl ether (3 x 10 ml) then dried under high vacuum for 48 hours to yield the title compound 1-(3-{[4-({6-[(3-chlorobenzoyl)amino]pyridin-3-yl}amino)-6-methoxyquinazolin-7-yl]oxy}propyl)piperidin-4-yl dihydrogen phosphate (di-hydrochloride) as an off-white solid (34 mg, 53 % yield) :

5 <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 11.98 (s, 1H), 11.11 (s, 1H), 8.87 (s, 1H), 8.79 (s, 1H), 8.58 (s, 1H), 8.24 (s, 2H), 8.09 (s, 1H), 7.99 (d, 1H), 7.68 (dd, 1H), 7.55 (t, 1H), 7.44 (s, 1H), 4.52 (m, 1H), 4.31 (t, 2H), 4.05 (s, 3H), 3.49 (m, 2H), 3.24 (m, 2H), 3.08 (m, 2H), 2.35 (m, 2H), 2.14 (m, 2H), 2.05 (t, 2H), 2.00 (m, 2H) :

MS (+ve ESI): 643.2 (M+H)<sup>+</sup>.

10 3-chloro-*N*-[5-({7-[3-(4-hydroxypiperidin-1-yl)propoxy]-6-methoxyquinazolin-4-yl}amino)pyridin-2-yl]benzamide, used as the starting material was obtained as described in example 2d but starting with 4-hydroxypiperidine (1.83 g, 18 mmol). The reaction yielded the desired compound as an off-white solid (860 mg, 85 % yield) :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 10.48 (s, 1H), 9.35 (br s, 1H), 8.80 (s, 1H), 7.99 (d, 1H), 7.84 (s, 1H), 7.61 (d, 1H), 7.53 (t, 1H), 7.21 (s, 1H), 4.22 (t, 2H), 4.06 (s, 1H), 3.99 (s, 3H), 3.49 (m, 1H), 2.72 (m, 2H), 2.48 (m, 2H), 2.11 (d, 2H), 1.95 (m, 2H), 1.72 (m, 2H), 1.43 (m, 2H) :

MS (+ve ESI): 563 (M+H)<sup>+</sup>.

**Example 10 - Preparation of Compound 10 in Table 1 - 4-{[4-({6-[(3-**

20 **chlorobenzoyl)amino]pyridin-3-yl}amino)-6-methoxyquinazolin-7-yl]oxy}butyl dihydrogen phosphate**

An analogous reaction to that described in example 9, but starting with 3-chloro-*N*-(5-{[7-(4-hydroxybutoxy)-6-methoxyquinazolin-4-yl]amino}pyridin-2-yl)benzamide (493 mg, 1.0 mmol) yielded the title compound as a pale yellow solid (250 mg, 88 % yield) :

25 <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 11.81 (s, 1H), 11.08 (s, 1H), 8.85 (s, 1H), 8.76 (d, 1H), 8.46 (s, 1H), 8.23 (m, 2H), 8.09 (s, 1H), 7.98 (d, 1H), 7.67 (d, 1H), 7.55 (t, 1H), 7.41 (s, 1H), 4.22 (t, 2H), 4.04 (s, 3H), 3.91 (q, 2H), 1.91 (m, 2H), 1.77 (m, 2H) :

<sup>31</sup>P-NMR (DMSO-d<sub>6</sub>): 0.00 (t, 1P):

MS (+ve ESI): 574 (M+H)<sup>+</sup>.

30 3-chloro-*N*-(5-{[7-(4-hydroxybutoxy)-6-methoxyquinazolin-4-yl]amino}pyridin-2-yl)benzamide used as the starting material was obtained as follows:

a) An analogous reaction to that described in example 2c, but starting with 7-(benzyloxy)-4-chloro-6-methoxyquinazoline (615 mg, 1.12 mmol-see patent WO 9722596)

and *N*-(5-aminopyridin-2-yl)-3-chlorobenzamide (362 mg, 1.46 mmol) afforded *N*-(5-[[7-(benzyloxy)-6-methoxyquinazolin-4-yl]amino]pyridin-2-yl)-3-chlorobenzamide (625 mg, 78 % yield) :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 11.23 (s, 1H), 10.65 (b s, 1H), 8.82 (s, 1H), 8.73 (s, 1H), 8.40 (s, 1H),  
5 8.25 (m, 2H), 8.10 (s, 1H), 8.02 (d, 1H), 7.65 (d, 1H), 7.53 (m, 4H), 7.38 (m, 3H), 5.36 (s, 2H), 4.08 (s, 3H).

b) *N*-(5-[[7-(benzyloxy)-6-methoxyquinazolin-4-yl]amino]pyridin-2-yl)-3-chlorobenzamide (615 mg, 1.12 mmol) was dissolved in trifluoroacetic acid (6 ml) and heated to 90 °C for 2 hours. The excess trifluoroacetic acid was evaporated and water was added  
10 cautiously to the slurry. This was added to a solution of ammonia (10 ml) and stirred rapidly. The resulting precipitate was isolated, washed with water and dried under high vacuum. The solid was triturated with acetone to afford 3-chloro-*N*-{5-[[7-hydroxy-6-methoxyquinazolin-4-yl]amino]pyridin-2-yl}benzamide (435 mg, 92 % yield) :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 10.90 (s, 1H), 10.32 (s, 1H), 9.53 (s, 1H), 8.77 (d, 1H), 8.39 (s, 1H),  
15 8.25 (m, 1H), 8.18 (d, 1H), 8.09 (s, 1H), 7.98 (d, 1H), 7.81 (s, 1H), 7.65 (d, 1H), 7.53 (t, 1H), 7.06 (s, 1H), 3.97 (s, 3H) :

MS (+ve ESI): 422 (M+H)<sup>+</sup>.

c) 3-chloro-*N*-{5-[[7-hydroxy-6-methoxyquinazolin-4-yl]amino]pyridin-2-yl}benzamide (431 mg, 1.01 mmol), 4-bromobutyloxyacetate (294 mg, 1.5 mmol) and potassium carbonate  
20 (414 mg, 3.00 mmol) were dissolved in dimethylacetamide (15 ml) and stirred at ambient temperature for 18 hours. The reaction mixture was concentrated and water (10 ml) added. The resultant precipitate was removed by filtration, washed with water and dried under high vacuum. The solid was recrystallised from acetonitrile to afford 4-{[4-((6-[[3-chlorobenzoyl]amino]pyridin-3-yl)amino)-6-methoxyquinazolin-7-yl]oxy}butyl acetate (337  
25 mg, 63 % yield) :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 8.76 (s, 1H), 8.45 (s, 1H), 8.26 (m, 1H), 8.20 (d, 1H), 8.09 (s, 1H),  
7.99 (d, 1H), 7.83 (s, 1H), 7.66 (d, 1H), 7.54 (t, 1H), 7.19 (s, 1H), 4.18 (t, 2H), 4.08 (t, 2H),  
3.95 (s, 3H), 2.00 (s, 3H), 1.84 (m, 2H), 1.75 (m, 2H) :

MS (+ve ESI): 536 (M+H)<sup>+</sup>.

30 d) 4-{[4-((6-[[3-chlorobenzoyl]amino]pyridin-3-yl)amino)-6-methoxyquinazolin-7-yl]oxy}butyl acetate (100 mg, 0.18 mmol) was dissolved in methanol (2.5 ml) and water (2.5 ml). Sodium hydroxide (15 mg, 0.36 mmol) was added and the reaction heated to 90 °C for 1 hour. The reaction was cooled and the precipitate was isolated by filtration, washed with

water and dried under high vacuum to yield 3-chloro-*N*-(5-{[7-(4-hydroxybutoxy)-6-methoxyquinazolin-4-yl]amino}pyridin-2-yl)benzamide (64 mg, 72 % yield) :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 10.91 (s, 1H), 9.59 (s, 1H), 8.77 (d, 1H), 8.47 (s, 1H), 8.26 (m, 1H), 8.19 (d, 1H), 8.09 (s, 1H), 7.99 (d, 1H), 7.83 (s, 1H), 7.66 (d, 1H), 7.54 (t, 1H), 7.18 (s, 1H),  
5 4.45 (t, 1H), 4.14 (t, 2H), 3.97 (s, 3H), 3.47 (q, 2H), 1.84 (m, 2H), 1.61 (m, 2H) :

MS (+ve ESI): 494 (M+H)<sup>+</sup>.

**Example 11 - Preparation of Compound 11 in Table 1 - 2-[(3-{[4-({6-[(3-chlorobenzoyl)amino]pyridin-3-yl}amino)-6-methoxyquinazolin-7-**

**10 yl]oxy}propyl)(methyl)amino]ethyl dihydrogen phosphate**

Di-*tert*-butyl-*N,N*-diethylphosphoramidite (730 µl, 2.60 mmol) was added to a mixture of 3-chloro-*N*-(5-{[7-(4-hydroxybutoxy)-6-methoxyquinazolin-4-yl]amino}pyridin-2-yl)benzamide (1.00 g, 1.86 mmol) and dry 1 *H*-tetrazole (400 mg, 5.59 mmol) in dimethylacetamide (25 ml). The reaction was stirred under an inert atmosphere at  
15 ambient temperature for 18 hours. Dichloromethane (150 ml) and aqueous sodium hydrogen carbonate solution (50 ml) were added and the reaction mixture stirred briefly. The aqueous layer was extracted with dichloromethane and the combined organics dried (sodium sulphate) and concentrated to give a yellow oil which was taken up in tetrahydrofuran (15 ml). The mixture was cooled to 0 °C and 30 % aqueous hydrogen peroxide (0.50 ml, 3.72 mmol) was  
20 added slowly and the reaction was stirred at 0 °C for 1 hour. A further equivalent of 30 % aqueous hydrogen peroxide was added and the reaction allowed to warm to ambient temperature. The reaction was cooled to 0 °C and a solution of sodium metabisulphite (30 ml, 0.52 M solution) was added. This mixture was warmed to ambient temperature and extracted with ethyl acetate (4 x 100 ml). The combined organics were dried (sodium sulphite) and  
25 concentrated to afford the crude phosphate ester as a yellow oil:

MS (+ve ESI) : 729 (M+H)<sup>+</sup>.

This was taken up in dioxane (70 ml) and treated dropwise with a 4.0 N solution of hydrogen chloride in dioxane (5 ml, 20 mmol). The white slurry was stirred at ambient temperature for 18 hours and diethyl ether was added (200 ml). The precipitate was filtered and washed with  
30 diethyl ether (3 x 30 ml) then dried under high vacuum to yield the title compound 2-[(3-{[4-({6-[(3-chlorobenzoyl)amino]pyridin-3-yl}amino)-6-methoxyquinazolin-7-yl]oxy}propyl)(methyl)amino]ethyl dihydrogen phosphate (di-hydrochloride) as an off-white solid (1.2 g, 93 % yield) :

$^1\text{H-NMR}$  ( $\text{DMSO-d}_6$ ) : 11.95 (m, 1H), 11.11 (s, 1H), 8.88 (s, 1H), 8.81 (s, 1H), 8.59 (m, 1H), 8.25 (m, 2H), 8.11 (m, 1H), 8.03 (d, 1H), 7.68 (m, 1H), 7.56 (t, 1H), 7.50 (m, 1H), 4.26 (m, 4H), 4.06 (s, 3H), 3.44 (m, 2H), 3.35 (m, 2H), 2.88 (s, 3H), 2.34 (m, 2H):

MS (+ve ESI) : 617 ( $\text{M}+\text{H}$ ) $^+$ .

5 3-chloro-*N*-{5-[(7-{3-[(2-hydroxyethyl)(methyl)amino]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl}benzamide used as the starting material was obtained as described in example 2d but starting with 2-(methylamino)ethanol (210 mg, 2.80 mmol). The reaction yielded the desired compound as an off-white solid (51 mg, 34 % yield) :

10  $^1\text{H-NMR}$  ( $\text{DMSO-d}_6$ ) : 10.50 (s, 1H), 9.41 (s, 1H), 8.81 (s, 1H), 8.46 (s, 1H), 8.27 (dd, 1H), 8.15 (d, 1H), 8.08 (s, 1H), 7.99 (d, 1H), 7.88 (s, 1H), 7.62 (d, 1H), 7.53 (t, 1H), 7.22 (s, 1H), 4.24 (t, 2H), 4.02 (s, 3H), 3.57 (t, 2H), 2.75 (t, 2H), 2.65 (t, 2H), 2.38 (s, 3H), 2.02 (m, 2H) :

MS (+ve ESI) : 537 ( $\text{M}+\text{H}$ ) $^+$ .

**Example 12 - Preparation of Compound 12 in Table 1 - [1-(3-{[4-{(6-{(3-**

15 **chlorobenzoyl)amino]pyridin-3-yl)amino)-6-methoxyquinazolin-7-yl]oxy}propyl)piperidin-2-yl]methyl dihydrogen phosphate**

Di-*tert*-butyl-*N,N*-diethylphosphoramidite (136  $\mu\text{l}$ , 0.49 mmol) was added to a mixture of 3-chloro-*N*-{5-[(7-{3-[2-(hydroxymethyl)piperidin-1-yl]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl}benzamide (202 mg, 0.35 mmol) and dry 1 *H*-tetrazole (61 mg, 0.87 mmol) in dimethylacetamide (0.5 ml). The reaction was stirred under an inert atmosphere at ambient temperature for 18 hours before addition of another equivalent of each reagent and further stirring for 6 hours. Dichloromethane (10 ml) and methanol (0.5 ml) were added and the mixture washed with aqueous potassium carbonate solution (20 %, 10 ml). The organics were dried (magnesium sulphate) and concentrated to give a yellow oil which was taken up in 25 tetrahydrofuran (2 ml). The mixture was cooled to 0  $^{\circ}\text{C}$  and 30 % aqueous hydrogen peroxide (72  $\mu\text{l}$ , 0.7 mmol) was added slowly and the reaction was stirred at 0  $^{\circ}\text{C}$  for 1 hour. A further equivalent of 30 % aqueous hydrogen peroxide was added and the reaction allowed to warm to ambient temperature. The reaction was cooled to 0  $^{\circ}\text{C}$  and a solution of sodium metabisulphite (0.5 ml, 0.52 M solution) was added. This mixture was warmed to ambient 30 temperature and extracted with dichloromethane : methanol (10:1). The combined organics were dried (magnesium sulphate) and concentrated to afford the crude phosphate ester as a yellow oil. This was taken up in dioxane (11 ml) and treated dropwise with a 4.0 N solution of hydrogen chloride in dioxane (0.55 ml, 2.20 mmol). The white slurry was stirred at ambient

temperature for 18 hours and diethyl ether was added (200 ml). The precipitate was filtered and washed with acetonitrile then purified according to the method described in example 2 to yield the title compound 1-(3-{[4-({6-[(3-chlorobenzoyl)amino]pyridin-3-yl}amino)-6-methoxyquinazolin-7-yl]oxy}propyl)piperidin-2-yl)methyl dihydrogen phosphate (di-hydrochloride) as an off-white solid (140 mg, 64 % yield) :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub> + CD<sub>3</sub>COOD) : 8.75 (s, 1H), 8.60 (br s, 1H), 8.22 (m, 2H), 8.06 (s, 1H), 7.98 (m, 2H), 7.61 (m, 1H), 7.50 (m, 1H), 7.42 (s, 1H), 4.29 (t, 2H), 4.11 (m, 1H), 3.99 (s, 3H), 3.85 (m, 1H), 3.23 (m, 1H), 3.09 (m, 1H), 2.52 (m, 2H), 2.25 (m, 2H), 1.73 (m, 5H), 1.50 (m, 2H) :

10 MS (+ve ESI) : 657 (M+H)<sup>+</sup>.

3-chloro-*N*-{5-[(7-{3-[2-(hydroxymethyl)piperidin-1-yl]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl}benzamide used as the starting material was obtained as described in example 2d but starting with 2-(hydroxymethyl)piperidine (323 mg, 2.8 mmol). The reaction yielded the desired compound as an off-white solid (63 mg, 39 % yield) :

15 <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>) : 10.50 (s, 1H), 9.37 (s, 1H), 8.82 (s, 1H), 8.49 (s, 1H), 8.27 (dd, 1H), 8.16 (d, 1H), 8.10 (s, 1H), 8.01 (d, 1H), 7.86 (s, 1H), 7.63 (d, 1H), 7.56 (t, 1H), 7.23 (s, 1H), 4.24 (t, 2H), 4.02 (s, 3H), 3.62 (m, 1H), 3.44 (m, 1H), 2.89 (m, 2H), 2.60 (m, 1H), 2.39 (m, 1H), 2.27 (m, 1H), 1.97 (t, 2H), 1.68-1.13 (m, 6H) :

MS (+ve ESI) : 577 (M+H)<sup>+</sup>.

20

**Example 13 - Preparation of Compound 13 in Table 1 - 2-[(5-{[4-({6-[(3-chlorobenzoyl)amino]pyridin-3-yl}amino)-6-methoxyquinazolin-7-yl]oxy}pentyl)(ethyl)amino]ethyl dihydrogen phosphate**

An analogous reaction to that described in example 12, but starting with 3-chloro-*N*-

25 (5-{[7-({5-[ethyl(2-hydroxyethyl)amino]pentyl}oxy)-6-methoxyquinazolin-4-yl]amino}pyridin-2-yl)benzamide (350 mg, 0.60 mmol), yielded the title compound (as the dihydrochloride salt, 340 mg, 77 % yield) as a pale yellow solid :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>) : 11.88 (br s, 1H), 11.05 (br s, 1H), 8.81 (m, 2H), 8.53 (s, 1H), 8.25 (m, 2H), 8.09 (s, 1H), 7.98 (d, 1H), 7.67 (m, 1H), 7.55 (t, 1H), 7.44 (s, 1H), 7.51 (m, 3H), 4.26

30 (m, 4H), 4.06 (s, 3H), 3.38 (m, 2H), 3.15 (m, 4H), 1.82 (m, 4H), 1.49 (m, 2H), 1.23 (m, 3H) :  
MS (+ve ESI) : 659 (M+H)<sup>+</sup>.

3-chloro-*N*-(5-{[7-({5-[ethyl(2-hydroxyethyl)amino]pentyl}oxy)-6-methoxyquinazolin-4-yl]amino}pyridin-2-yl)benzamide, used as the starting material, was obtained as follows:



a) An analogous reaction to that described in example 10c but starting with bromo-5-chloropentane (280 mg, 1.50 mmol) yielded 3-chloro-*N*-[5-({7-[(5-chloropentyl)oxy]-6-methoxyquinazolin-4-yl}amino)pyridin-2-yl]benzamide (162 mg, 20 % yield) :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>) : 10.90 (s, 1H), 9.61 (s, 1H), 8.77 (s, 1H), 8.48 (s, 1H), 8.23 (m, 2H),  
5 8.09 (s, 1H), 7.83 (s, 1H), 7.66 (d, 1H), 7.55 (t, 1H), 7.18 (s, 1H), 4.15 (t, 2H), 3.96 (s, 3H),  
3.67 (t, 2H), 1.84 (m, 4H), 1.57 (m, 2H).

b) An analogous reaction to that described in example 2d but starting with 2-(ethylamino)ethanol (93 mg, 0.95 mmol) and 3-chloro-*N*-[5-({7-[(5-chloropentyl)oxy]-6-methoxyquinazolin-4-yl}amino)pyridin-2-yl]benzamide (100 mg, 0.19 mmol) yielded 3-chloro-*N*-[5-({7-({5-[ethyl(2-hydroxyethyl)amino]pentyl}oxy)-6-methoxyquinazolin-4-yl}amino)pyridin-2-yl]benzamide (50 mg, 45 % yield) :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>) : 11.22 (m, 1H), 11.05 (br s, 1H), 8.82 (s, 1H), 8.70 (d, 1H), 8.27 (m,  
1H), 8.14 (m, 2H), 8.09 (m, 1H), 7.98 (m, 1H), 7.66 (m, 1H), 7.54 (m, 1H), 7.40 (s, 1H), 4.20  
(t, 2H), 3.99 (s, 3H), 3.71 (t, 2H), 3.17 (m, 6H), 1.84 (m, 2H), 1.72 (m, 2H), 1.45 (m, 2H),  
15 1.20 (t, 3H) :

MS (-ve ESI) : 577 (M-H)<sup>-</sup>,

MS (+ve ESI) : 579 (M+H)<sup>+</sup>.

**Example 14 - Preparation of Compound 14 in Table 1 - 4-[(3-[(4-[(3-**

20 **chlorobenzoyl)amino]pyridin-3-yl}amino)-6-methoxyquinazolin-7-**  
**yl]oxy]propyl)(ethylamino)butyl dihydrogen phosphate**

An analogous reaction to that described in example 12, but starting with 3-chloro-*N*-[5-[(7-{3-[ethyl(4-hydroxybutyl)amino]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl]benzamide (1.02 g, 1.76 mmol) yielded the title compound (as the dihydrochloride salt,  
25 600 mg, 47 % yield) as a pale yellow solid :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>) : 11.90 (br s, 1H), 11.61 (br s, 1H), 8.81 (m, 2H), 8.55 (s, 1H), 8.25 (m,  
2H), 8.09 (s, 1H), 7.98 (d, 1H), 7.67 (m, 1H), 7.55 (t, 1H), 7.44 (s, 1H), 4.30 (m, 2H), 4.03 (s,  
3H), 3.19 (m, 6H), 2.88 (m, 2H), 2.30 (m, 2H), 1.78 (m, 2H), 1.66 (m, 2H), 1.25 (m, 3H) :

MS (+ve ESI) : 659 (M+H)<sup>+</sup>.

30 3-chloro-*N*-[5-[(7-{3-[ethyl(4-hydroxybutyl)amino]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl]benzamide, used as the starting material, was obtained as described in example 2d, but starting with 4-ethylamino-1-butanol (226 ml, 1.93 mmol). The reaction yielded the desired compound as the di-trifluoroacetic acid salt (113 mg, 51 % yield) :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>) : 11.04 (s, 1H), 10.99 (br s, 1H), 8.81 (s, 1H), 8.70 (m, 1H), 8.28 (m, 1H), 8.16 (m, 1H), 8.08 (m, 2H), 7.98 (m, 1H), 7.67 (m, 1H), 7.55 (t, 1H), 7.38 (s, 1H), 4.30 (t, 2H), 3.99 (s, 3H), 3.42 (t, 2H), 3.20 (m, 6H), 2.22 (m, 2H), 1.70 (m, 2H), 1.48 (m, 2H), 1.22 (t, 3H) :

5 MS (-ve ESI) : 577 (M-H)<sup>-</sup>,

MS (+ve ESI) : 579 (M+H)<sup>+</sup>.

**Example 15 - Preparation of Compound 15 in Table 1 - 2-[(3-{[4-{(3-fluorobenzoyl)amino}pyridin-3-yl)amino]-6-methoxyquinazolin-7-**

**10 yl]oxy}propyl)(methyl)amino]ethyl dihydrogen phosphate**

An analogous reaction to that described in example 7, but starting with 3-fluoro-*N*-{5-[(7-{3-[(2-hydroxyethyl)(methyl)amino]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl}benzamide (1.10 g, 2.11 mmol) yielded the title compound (as the formate salt, 180 mg, 13 % yield) as a pale yellow solid :

15 <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>) : 12.15 (br s, 1H), 10.99 (br s, 1H), 8.81 (m, 2H), 8.64 (s, 1H), 8.25 (m, 1H), 7.88 (m, 2H), 7.51 (m, 3H), 4.26 (m, 4H), 4.06 (s, 3H), 3.43 (m, 2H), 3.34 (m, 2H), 2.86 (s, 3H), 2.34 (m, 2H) :

MS (+ve ESI) : 601 (M+H)<sup>+</sup>.

3-fluoro-*N*-{5-[(7-{3-[(2-hydroxyethyl)(methyl)amino]propoxy}-6-methoxyquinazolin-4-yl)amino]pyridin-2-yl}benzamide, used as the starting material, was obtained in an analogous reaction to that described in example 7d but starting with 2-(methylamino)ethanol (780 µl, 9.67 mmol). The reaction yielded the desired compound (1.2 g, 72 % yield) :

20 <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>) : 10.85 (m, 1H), 9.61 (s, 1H), 8.78 (m, 1H), 8.45 (s, 1H), 8.28 (m, 1H), 8.19 (m, 1H), 7.87 (m, 3H), 7.55 (m, 1H), 7.43 (m, 1H), 7.18 (s, 1H), 4.43 (m, 1H), 4.16 (t, 2H), 3.98 (s, 3H), 3.44 (m, 2H), 2.50 (m, 2H), 2.41 (t, 2H), 2.20 (s, 3H), 1.89 (m, 2H) :

MS (-ve ESI) : 519 (M-H)<sup>-</sup>,

MS (+ve ESI) : 521 (M+H)<sup>+</sup>.

**Example 16 - Preparation of Compound 16 in Table 2 - 2-[(3-{[4-{(2-{[3-chloro-4-fluorobenzoyl]amino}pyrimidin-5-yl)amino)-6-methoxyquinazolin-7-yl]oxy}propyl)(cyclohexyl)amino]ethyl dihydrogen phosphate**

Dry 1*H*-tetrazole (113 mg, 1.62 mmol) and di-*tert*-butyl diethylphosphoramidite (201 mg, 0.81 mmol) were added to a solution of 3-chloro-*N*-{5-[(7-{3-[cyclohexyl(2-hydroxyethyl)amino]propoxy}-6-methoxyquinazolin-4-yl)amino]pyrimidin-2-yl}-4-fluorobenzamide (126 mg, 0.57 mmol) in dimethylformamide (2 ml). The reaction was stirred under an inert atmosphere at ambient temperature for 20 hours. The reaction mixture was diluted with ethyl acetate (50 ml) and washed with three portions of aqueous sodium hydrogen carbonate. The organics were dried over magnesium sulphate and concentrated to an oil. The oil was dissolved in tetrahydrofuran (3 ml) and cooled to 0 °C. Hydrogen peroxide (69 µl of a 30 % w/v aqueous solution) was added and the reaction stirred for 48 hours at ambient temperature during which a further portion of hydrogen peroxide (35 µl) was added. The reaction was quenched with aqueous sodium metabisulphite, extracted into dichloromethane and dried over sodium sulphate. Purification by flash chromatography on alumina, eluting with 0-2 % methanol in dichloromethane, yielded a yellow solid after trituration with diethyl ether. The yellow solid (56 mg) was dissolved in 1,4 dioxane (2 ml) and hydrogen chloride (0.10 ml of a 4.0 N solution in 1,4-dioxane, 0.41 mmol) was added dropwise to the solution. The reaction mixture was stirred for 20 hours at ambient temperature. The reaction mixture was diluted with diethyl ether and the solid was collected by suction filtration and washed with diethyl ether to yield the title compound (as a solid dihydrochloride salt, 49 mg, 11 % yield) :

<sup>1</sup>H-NMR (DMSO-*d*<sub>6</sub>): 12.10 (s, 1H), 9.20 (s, 2H), 8.85 (s, 1H), 8.60 (s, 1H), 8.20 (dd, 1H), 7.95-8.05 (m, 1H), 7.50-7.60 (m, 2H), 4.40 (t, 2H), 4.20-4.30 (m, 2H), 4.00 (s, 3H), 3.20-3.45 (m, 4H), 2.20-2.40 (m, 2H), 2.00-2.10 (m, 2H), 1.75-1.90 (m, 2H), 1.55-1.65 (m, 1H), 1.25-1.50 (m, 4H), 1.10-1.20 (m, 1H) :

<sup>31</sup>P-NMR {<sup>1</sup>H} (DMSO- *d*<sub>6</sub>): 0.55 (s, 1P) :

MS (+ve ESI): 704.5/706.5 (M+H)<sup>+</sup>.

3-chloro-*N*-{5-[(7-{3-[cyclohexyl(2-hydroxyethyl)amino]propoxy}-6-methoxyquinazolin-4-yl)amino]pyrimidin-2-yl}-4-fluorobenzamide used as starting material was obtained as follows:

a) 3-Chloro-4-fluorobenzoyl chloride (1.52 g, 7.88 mmol) was added to a stirred solution of 2-amino-5-nitropyrimidine (1.00 g, 7.14 mmol) in anhydrous pyridine (20 ml) at ambient

temperature and the reaction heated at reflux for 7 hours. The reaction was cooled to ambient temperature, poured into water (200 ml) and allowed to stand for 18 hours. The aqueous phase was extracted with dichloromethane (3 x 75 ml) and the combined organic extracts were washed with brine (2 x 100 ml) and dried (magnesium sulphate). Solvent evaporation *in*

- 5 *vacuo* followed by purification by flash chromatography on silica gel, eluting with dichloromethane : methanol (99:1 then 98:2) yielded 3-chloro-4-fluoro-*N*-(5-nitropyrimidin-2-yl)benzamide (1.71 g, 81 % yield) as a brown gum :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>) : 11.86 (br s, 1H), 9.44 (s, 2H), 8.20 (m, 1H), 7.98 (m, 1H), 7.58 (t, 1H)

:

- 10 MS (-ve ESI) : 295 (M-H)<sup>-</sup>,  
MS (+ve ESI) : 297 (M+H)<sup>+</sup>.

b) 10 % Platinum on carbon (149 mg) was added to a stirred suspension of 3-chloro-4-fluoro-*N*-(5-nitropyrimidin-2-yl)benzamide (743 mg, 2.51 mmol) in ethanol (50 ml) at ambient temperature and the reaction stirred for 18 hours under an atmosphere of hydrogen.

- 15 The reaction was filtered through a pad of celite and the solvent evaporated *in vacuo* to yield a solid which was taken up in ethyl acetate : ethanol (4:1) and filtered (0.45 μm PTFE filter). The solvent was evaporated to yield *N*-(5-aminopyrimidin-2-yl)-3-chloro-4-fluorobenzamide (5.77 g, 99 % yield) as a brown solid :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>) : 10.64 (br s, 1H), 8.15 (m, 1H), 8.07 (s, 2H), 7.94 (m, 1H), 7.54 (t,

- 20 1H), 5.41 (s, 2H) :

MS (-ve ESI) : 265 (M-H)<sup>-</sup>,  
MS (+ve ESI) : 267 (M+H)<sup>+</sup>.

c) Hydrogen chloride (3.0 ml of a 4.0 N solution in dioxane, 12.0 mmol) was added to a stirred solution of 7-(benzyloxy)-4-chloro-6-methoxyquinazoline (3.40 g, 11.25 mmol) and *N*-

- 25 (5-aminopyrimidin-2-yl)-3-chloro-4-fluorobenzamide (3.00 g, 11.25 mmol) in

dimethylacetamide (50 ml) and the reaction heated at 50 °C for 3.5 hours. The reaction was allowed to cool to ambient temperature and the precipitated solid was collected by suction filtration. Washing of the solid with diethyl ether followed by drying *in vacuo* yielded *N*-(5-[[7-(benzyloxy)-6-methoxyquinazolin-4-yl]amino]pyrimidin-2-yl)-3-chloro-4-

- 30 fluorobenzamide (5.33 g, 79 % yield) as a cream solid :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>) : 11.80 (br s, 1H), 11.27 (br s, 1H), 9.11 (s, 2H), 8.85 (s, 1H), 8.42 (s, 1H), 8.10 (m, 1H), 8.00 (m, 1H), 7.37-7.60 (m, 7H), 5.34 (s, 2H), 4.03 (s, 3H) :

MS (-ve ESI) : 529 (M-H)<sup>-</sup>,

MS (+ve ESI) : 531 (M+H)<sup>+</sup>.

d) *N*-(5-([7-(benzyloxy)-6-methoxyquinazolin-4-yl]amino)pyrimidin-2-yl)-3-chloro-4-fluorobenzamide (5.33 g, 8.83 mmol) was added to trifluoroacetic acid (50 ml) and the reaction heated at reflux for 2 hours. The reaction was cooled to ambient temperature, the  
 5 volatiles were evaporated *in vacuo* and the resultant brown oil was azeotroped with dichloromethane (2 x 50 ml). Addition of diethyl ether (50 ml) caused the formation of a precipitate which was collected by suction filtration and dried *in vacuo* to yield 3-chloro-4-fluoro-*N*-(5-[(7-hydroxy-6-methoxyquinazolin-4-yl)amino]pyrimidin-2-yl)benzamide (trifluoroacetate salt, 4.73 g, 97 % yield) as an off-white solid :

10 <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>) : 11.27 (br s, 1H), 9.03 (s, 2H), 8.81 (s, 1H), 8.19 (s, 1H), 8.00 (m, 2H), 7.57 (t, 1H), 7.21 (s, 1H), 4.00 (s, 3H) :

MS (-ve ESI) : 439 (M-H)<sup>-</sup>,

MS (+ve ESI) : 441 (M+H)<sup>+</sup>.

e) A mixture of 3-chloro-4-fluoro-*N*-(5-[(7-hydroxy-6-methoxyquinazolin-4-yl)amino]pyrimidin-2-yl)benzamide (750 mg, 1.35 mmol), 1,3-dibromopropane (327 mg, 1.62 mmol) and potassium carbonate (411 mg, 2.98 mmol) in dimethylacetamide (3 ml) were stirred at ambient temperature for 20 hours before *N*-cyclohexylethanolamine (965 mg, 6.75 mmol) was added to the solution. The reaction mixture was stirred at ambient temperature for 48 hours then concentrated under reduced pressure. Purification by flash chromatography on  
 20 silica gel, eluting with dichloromethane : methanol : saturated ammonia (93:5:2 to 78:20:2) yielded 3-chloro-*N*-(5-[(7-{3-[cyclohexyl(2-hydroxyethyl)amino]propoxy}-6-methoxyquinazolin-4-yl)amino]pyrimidin-2-yl)-4-fluorobenzamide (126 mg, 15 % yield) as a yellow solid :

25 <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>) : 11.10 (s, 1H), 9.80 (s, 1H), 9.15 (s, 2H), 8.45 (s, 1H), 8.20 (d, 2H), 7.95-8.05 (m, 1H), 7.80 (s, 1H), 7.50-7.60 (m, 1H), 7.20 (s, 1H), 4.25 (t, 2H), 4.00 (s, 3H), 3.30-3.50 (m, 4H), 2.50-2.80 (m, 4H), 1.80-2.00 (m, 2H), 1.50-1.75 (m, 4H), 1.10-1.30 (m, 5H) :

MS (-ve ESI) : 622 (M-H)<sup>-</sup>,

MS (+ve ESI) : 624 (M+H)<sup>+</sup>.

**Example 17 - Preparation of Compound 17 in Table 2 - 2-[(3-{[4-{(2-[(3-chloro-4-fluorobenzoyl)amino]pyrimidin-5-yl)amino)-6-methoxyquinazolin-7-yl]oxy}propyl)(ethyl)amino]ethyl dihydrogen phosphate**

Dry 1*H*-tetrazole (1.34 g, 19.21 mmol) and di-*tert*-butyl diethylphosphoramidite (2.95 g, 11.85 mmol) were added in 3 aliquots to a solution of 3-chloro-*N*-{5-[(7-{3-[ethyl(2-hydroxyethyl)amino]propoxy}-6-methoxyquinazolin-4-yl)amino]pyrimidin-2-yl}-4-fluorobenzamide (1.5 g, 2.63 mmol) in dimethylacetamide (60 ml). The reaction was stirred under an inert atmosphere at ambient temperature for 72 hours. The reaction mixture was diluted with ethyl acetate (200 ml) and washed with three portions of aqueous sodium hydrogen carbonate. The organics were dried over sodium sulphate and concentrated to an oil. The oil was dissolved in tetrahydrofuran (25 ml) and cooled to 0 °C. Hydrogen peroxide (599 µl of a 30 % w/v aqueous solution) was added and the reaction stirred for 20 hours at ambient temperature during which a further portion of hydrogen peroxide (300 µl) was added. The reaction was quenched at 0 °C with aqueous sodium metabisulphite, extracted into ethyl acetate, dichloromethane and methanol and dried over magnesium sulphate. Purification by flash chromatography on alumina, eluting with 0-5 % methanol in dichloromethane yielded a yellow foam. The yellow foam (859 mg) was dissolved in 1,4 dioxane (50 ml) and hydrogen chloride (1.7 ml of a 4.0 N solution in 1,4-dioxane, 6.78 mmol) was added dropwise to the solution. The reaction mixture was stirred for 20 hours at ambient temperature. The reaction mixture was diluted with diethyl ether (300 ml) the solid collected by suction filtration and washed with diethyl ether to yield the title compound (as a solid dihydrochloride salt, 799 mg, 42 % yield) :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 12.30 (s, 1H), 11.20 (s, 1H), 9.20 (s, 2H), 8.90 (s, 1H), 8.20 (dd, 1H), 7.95-8.05 (m, 1H), 7.50-7.60 (m, 1H), 7.40 (s, 1H), 4.20-4.40 (t, 4H), 4.00 (s, 3H), 3.50-3.60 (m, 2H), 3.20-3.20 (m, 4H), 2.20-2.40 (m, 2H), 1.30 (t, 3H) :

<sup>31</sup>P-NMR {<sup>1</sup>H} (DMSO-d<sub>6</sub>): -0.23 (s, 1P) :

MS (+ve ESI): 650, 652 (M+H)<sup>+</sup>.

3-chloro-*N*-{5-[(7-{3-[ethyl(2-hydroxyethyl)amino]propoxy}-6-methoxyquinazolin-4-yl)amino]pyrimidin-2-yl}-4-fluorobenzamide used as starting material was obtained as follows:

A mixture 3-chloro-4-fluoro-*N*-{5-[(7-hydroxy-6-methoxyquinazolin-4-yl)amino]pyrimidin-2-yl}benzamide (8 g, 14.4 mmol), 1-bromo-3-chloropropane (2.49 g, 15.9 mmol) and caesium carbonate (9.38 g, 28.8 mmol) in dimethylformamide (80 ml) were stirred at ambient

temperature for 20 hours before N-ethylethanolamine (6.4 g, 72 mmol) was added to the solution. The reaction mixture was stirred at 70 °C for 48 hours then concentrated under reduced pressure. Purification by flash chromatography on silica gel, eluting with 1-20 %

methanol in dichloromethane containing 2 % concentrated ammonia, yielded 3-chloro-*N*-{5-[(7-{3-[ethyl(2-hydroxyethyl)amino]propoxy}-6-methoxyquinazolin-4-yl)amino]pyrimidin-2-yl}-4-fluorobenzamide (2.5 g, 30 % yield) as a yellow solid :

<sup>1</sup>H-NMR (DMSO-*d*<sub>6</sub>): 11.10 (s, 1H), 9.75 (s, 1H), 9.15 (s, 2H), 8.45 (s, 1H), 8.20 (dd, 1H), 7.95-8.05 (m, 1H), 7.80 (s, 1H), 7.50-7.60 (m, 1H), 7.20 (s, 1H), 4.25 (br s, 1H), 4.20 (t, 2H), 4.00 (s, 3H), 3.40-3.50 (m, 2H), 2.50-2.65 (m, 6H), 1.80-2.00 (m, 2H), 0.95 (t, 3H) :

MS (+ve ESI): 570, 572 (M+H)<sup>+</sup>,

MS (-ve ESI): 568, 570 (M-H)<sup>-</sup>.

**Example 18 - Preparation of Compound 18 in Table 2 - 3-[[4-({2-[(3-chlorobenzoyl)amino]pyrimidin-5-yl}amino)-6-methoxyquinazolin-7-yl]oxy]propyl**

**15 dihydrogen phosphate**

An analogous reaction to that described in example 9, but starting with 3-chloro-*N*-(5-{[7-(3-hydroxypropoxy)-6-methoxyquinazolin-4-yl]amino}pyrimidin-2-yl)benzamide (100 mg, 0.21 mmol) yielded the title compound as a pale yellow solid (66 mg, 56 % yield) :

<sup>1</sup>H-NMR (DMSO-*d*<sub>6</sub>): 12.10 (s, 1H), 11.26 (s, 1H), 9.13 (s, 2H), 8.89 (s, 1H), 8.54 (s, 1H), 8.00 (s, 1H), 7.92 (d, 1H), 7.68 (m, 1H), 7.54 (t, 1H), 7.41 (s, 1H), 4.28 (t, 2H), 4.03 (s, 3H), 4.02 (q, 2H), 2.15 (m, 2H) :

MS (+ve ESI): 561 (M+H)<sup>+</sup>.

3-chloro-*N*-(5-{[7-(3-hydroxypropoxy)-6-methoxyquinazolin-4-yl]amino}pyrimidin-2-yl)benzamide used as the starting material was obtained in an analogous reaction to that described in example 16e, but starting with 3-bromopropanol (154 mg, 1.10 mmol) and 3-chloro-*N*-(5-{[7-(3-hydroxypropoxy)-6-methoxyquinazolin-4-yl]amino}pyrimidin-2-yl)benzamide (520 mg, 1 mmol-see patent WO 0121597) but no amine was added. The reaction yielded the desired compound as an off-white solid (151 mg, 31 % yield) :

<sup>1</sup>H-NMR (DMSO-*d*<sub>6</sub>): 11.11 (s, 1H), 9.72 (s, 1H), 9.11 (s, 2H), 8.47 (s, 1H), 8.02 (s, 1H), 7.93 (d, 1H), 7.79 (s, 1H), 7.65 (d, 1H), 7.53 (t, 1H), 7.21 (s, 1H), 4.56 (t, 1H), 4.20 (t, 2H), 3.96 (s, 3H), 3.58 (q, 2H), 1.94 (m, 2H) :

MS (+ve ESI): 481 (M+H)<sup>+</sup>.

**Example 19 - 1-[3-({4-[(2-[(3-chloro-4-fluorophenyl)amino]methyl}pyrimidin-5-yl)amino]-6-methoxyquinazolin-7-yl}oxy)propyl]piperidin-4-yl dihydrogen phosphate**  
**Preparation of Compound 19 in Table 2 (M578976)**

An analogous reaction to that described in example 9, but starting with 1-[3-({4-[(2-  
 5 {[(3-chloro-4-fluorophenyl)amino]methyl}pyrimidin-5-yl)amino]-6-methoxyquinazolin-7-  
 yl}oxy)propyl]piperidin-4-ol (500 mg, 0.88 mmol) yielded the title compound (121 mg, 21 %  
 yield) :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>) : 12.20 (s, 1H), 10.69 (s, 1H), 9.27 (s, 2H), 9.00 (s, 1H), 8.63 (s, 1H),  
 7.54 (s, 1H), 7.11 (dd, 1H), 6.80 (dd, 1H), 6.65 (m, 1H), 5.22 (br s, 5H), 4.51 (s, 1H), 4.33 (t,  
 10 2H), 4.07 (s, 3H), 3.58-3.39 (m, 2H), 3.30-3.09 (m, 4H), 2.35 (m, 2H), 2.17 (m, 2H), 2.00 (m,  
 2H) :

<sup>31</sup>P-NMR {<sup>1</sup>H} (DMSO-d<sub>6</sub>): -1.0 (s, 1P)

MS (-ve ESI) : 646/648 (M-H)<sup>-</sup>,

MS (+ve ESI) : 648/650 (M+H)<sup>+</sup>.

15 1-[3-({4-[(2-[(3-chloro-4-fluorophenyl)amino]methyl}pyrimidin-5-yl)amino]-6-  
 methoxyquinazolin-7-yl}oxy)propyl]piperidin-4-ol used as starting material was obtained as  
 follows:

a) Sodium hydride (1.20 g, 31.65 mmol) was added at ambient temperature to a solution  
 of 2-(diethoxymethyl)pyrimidin-5-amine (1.87 g, 9.49 mmol, see-patent WO 0121597) in  
 20 tetrahydrofuran (60 ml). The reaction mixture was stirred for 10 minutes before the addition  
 of 4-chloro-6-methoxy-7-(3-chloropropoxy)quinazoline (4.00 g, 13.93 mmol). The reaction  
 mixture was heated to reflux for 3 hours, cooled to ambient temperature and diluted with ethyl  
 acetate (80 ml). The resultant precipitate was removed by filtration through celite and the  
 filtrate concentrated to a brown powder. This was dissolved in dichloromethane : methanol  
 25 (9:1) and purified by flash chromatography on silica gel. Elution with dichloromethane :  
 methanol (9:1), afforded 7-(3-chloropropoxy)-N-[2-(diethoxymethyl)pyrimidin-5-yl]-6-  
 methoxyquinazolin-4-amine as an orange powder (5.47 g, 88 % yield, 74 % pure), used crude  
 in the next reaction.

MS (+ve ESI) : 448 (M+H)<sup>+</sup>.

30 b) 7-(3-Chloropropoxy)-N-[2-(diethoxymethyl)pyrimidin-5-yl]-6-methoxyquinazolin-4-  
 amine (4.62 g, 10.3 mmol) was dissolved in a mixture of dichloromethane : trifluoroacetic  
 acid : water (6:1:1, 200 ml) and stirred at ambient temperature for 7 hours. The  
 dichloromethane was removed and the residue suspended in diethyl ether (500 ml), filtered



and dried in a vacuum oven for 24 hours to afford 5-{[7-(3-chloropropoxy)-6-methoxyquinazolin-4-yl]amino}pyrimidine-2-carbaldehyde as the trifluoroacetic acid salt (4.64 g, 92 % yield), used crude in the next reaction.

- c) Sodium cyanoborohydride (386 mg, 6.15 mmol) and acetic acid (586  $\mu$ l, 10.3 mmol) were added to a solution of 5-{[7-(3-chloropropoxy)-6-methoxyquinazolin-4-yl]amino}pyrimidine-2-carbaldehyde (2.50 g, 5.12 mmol) and 4-fluoro-3-chloroaniline (3.73 g, 25.6 mmol) in methanol (25 ml) under nitrogen. The reaction was stirred at ambient temperature for 2 hours, diluted with diethyl ether (180 ml) and the resultant solid collected by filtration. The solid was washed with diethyl ether and dried in a vacuum oven to give *N*-(2-[[[(3-chloro-4-fluorophenyl)amino]methyl]pyrimidin-5-yl]-7-(3-chloropropoxy)-6-methoxyquinazolin-4-amine as a yellow powder (1.81 g, 70 % yield). The product was used directly in the next reaction.
- d) An analogous reaction to that described in example 2d, but starting with 4-hydroxypiperidine (1.00 g, 9.95 mmol) and *N*-(2-[[[(3-chloro-4-fluorophenyl)amino]methyl]pyrimidin-5-yl]-7-(3-chloropropoxy)-6-methoxyquinazolin-4-amine (1.0 g, 2.0 mmol). Purification by flash chromatography, eluting with dichloromethane : methanol (9:1) followed by increased polarity to dichloromethane : methanol : ammonia (9:1:0.6) yielded 1-[3-({4-[(2-[[[(3-chloro-4-fluorophenyl)amino]methyl]pyrimidin-5-yl]amino]-6-methoxyquinazolin-7-yl}oxy)propyl)piperidin-4-ol as a pale yellow solid (700 mg, 62 % yield) :
- $^1\text{H-NMR}$  (DMSO- $d_6$ ) : 9.73 (s, 1H), 9.20 (s, 2H), 8.50 (s, 1H), 7.80 (s, 1H), 7.22 (s, 1H), 7.10 (dd, 1H), 6.78 (dd, 1H), 6.64 (m, 1H), 6.48 (dd, 1H), 4.50 (d, 1H), 4.44 (d, 2H), 4.18 (t, 2H), 3.97 (s, 3H), 3.44 (m, 1H), 2.73 (m, 2H), 2.42 (m, 2H), 2.05-1.91 (m, 4H), 1.71 (m, 2H), 1.41 (m, 2H) :
- $^{19}\text{F-NMR}$  (DMSO- $d_6$ ) : -134.4 (m) :
- MS (-ve ESI) : 566, 568 (M-H)<sup>-</sup>,  
MS (+ve ESI) : 568, 570 (M+H)<sup>+</sup>.

**Example 20 - Preparation of Compound 20 in Table 2 - 3-[(3-{[4-({2-[(3-chloro-4-fluorobenzyl)oxy]pyrimidin-5-yl}amino)-6-methoxyquinazolin-7-yl]oxy}propyl)amino]-3-methylbutyl dihydrogen phosphate**

An analogous reaction to that described in example 9, but starting with 3-[(3-{[4-({2-[(3-chloro-4-fluorobenzyl)oxy]pyrimidin-5-yl}amino)-6-methoxyquinazolin-7-

yl]oxy}propyl)amino]-3-methylbutan-1-ol (1.14 g, 2.00 mmol) yielded the title compound as a pale yellow solid (149 mg, 17 % yield) :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 9.73 (s, 1H), 8.98 (s, 2H), 8.43 (s, 1H), 7.82 (s, 1H), 7.74 (m, 1H), 7.53 (m, 1H), 7.46 (t, 1H), 7.25 (s, 1H), 5.41 (s, 2H), 4.24 (t, 2H), 3.99 (s, 3H), 3.92 (m, 2H), 3.0 (t, 2H), 2.21 (m, 2H), 1.85 (t, 2H), 1.31 (s, 6H) :

MS (+ve ESI): 651 (M+H)<sup>+</sup>.

3-[(3-{[4-({2-[(3-chloro-4-fluorobenzyl)oxy]pyrimidin-5-yl}amino)-6-methoxyquinazolin-7-yl]oxy}propyl)amino]-3-methylbutan-1-ol, used as the starting material, was obtained as follows:

- 10 a) 2-[(3-chloro-4-fluorobenzyl)oxy]pyrimidin-5-amine (2.54 g, 10.0 mmol, see-patent WO 0121597) and 4-chloro-6-methoxy-7-(3-chloroxypropoxy)quinazoline (2.87 g, 10 mmol) were dissolved in dimethylacetamide (60 ml) and warmed to 40 °C. Hydrogen chloride (4 N solution in 1,4 dioxane, 2.5 ml, 10 mmol) was added slowly and the reaction heated at 70 °C for 30 minutes. The reaction was cooled, diluted with ether and the resultant precipitate  
15 collected by filtration and washed with diethyl ether. The solid was triturated with acetonitrile to afford *N*-{2-[(3-chloro-4-fluorobenzyl)oxy]pyrimidin-5-yl}-7-(3-chloropropoxy)-6-methoxyquinazolin-4-amine (di- hydrochloride salt) as an off-white solid (4.88 g, 90 % yield)

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 8.96 (s, 2H), 8.82 (s, 1H), 8.40 (s, 1H), 7.70 (m, 1H), 7.51 (m, 1H),  
20 7.43 (m, 1H), 7.38 (s, 1H), 5.41 (s, 2H), 4.30 (t, 2H), 4.02 (s, 3H), 3.82 (t, 2H), 2.28 (t, 2H) :  
MS (+ve ESI): 504 (M+H)<sup>+</sup>.

- b) An analogous reaction to that described in example 2d, but starting with *N*-{2-[(3-chloro-4-fluorobenzyl)oxy]pyrimidin-5-yl}-7-(3-chloropropoxy)-6-methoxyquinazolin-4-amine (2.7 g, 5.00 mmol) and 3-amino-3-methylbutanol (2.57 g, 25.0 mmol). The reaction  
25 yielded 3-[(3-{[4-({2-[(3-chloro-4-fluorobenzyl)oxy]pyrimidin-5-yl}amino)-6-methoxyquinazolin-7-yl]oxy}propyl)amino]-3-methylbutan-1-ol as a colourless solid (2.22 g, 78 % yield) :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 9.65 (s, 1H), 8.97 (s, 2H), 8.47 (s, 2H), 7.79 (s, 1H), 7.72 (m, 1H), 7.51 (m, 1H), 7.45 (t, 1H), 7.21 (s, 1H), 5.41 (s, 2H), 4.21 (t, 2H), 3.98 (s, 3H), 3.82 (t, 2H), 2.69  
30 (t, 2H), 1.90 (t, 2H), 1.53 (t, 2H), 1.04 (s, 6H) :

MS (+ve ESI): 571 (M+H)<sup>+</sup>.

**Example 21 - Preparation of Compound 21 in Table 3 - [2-({[4-({2-[(3-chloro-4-fluorobenzoyl)amino]pyrimidin-5-yl)amino)-6-methoxyquinazolin-7-yl]oxy)methyl)cyclopropyl)methyl dihydrogen phosphate**

An analogous reaction to that described in example 9, but starting with 3-chloro-4-fluoro-*N*-{5-[(7-([2-(hydroxymethyl)cyclopropyl)methoxy]-6-methoxyquinazolin-4-yl)amino]pyrimidin-2-yl}benzamide (234 mg, 0.44 mmol) yielded the title compound as a pale orange solid (49 mg, 58 % yield) :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 11.30 (s, 1H), 9.15 (s, 2H), 8.75 (s, 1H), 8.20 (d, 1H), 8.05 (m, 2H), 7.70 (t, 1H), 7.25 (s, 1H), 4.20 (m, 1H), 4.10-4.00 (m, 4H), 3.90 (m, 2H), 1.40-1.00 (m, 2H), 0.70 (m 2H) :

MS (+ve ESI): 605 (M+H)<sup>+</sup>.

3-chloro-4-fluoro-*N*-{5-[(7-([2-(hydroxymethyl)cyclopropyl)methoxy]-6-methoxyquinazolin-4-yl)amino]pyrimidin-2-yl}benzamide, used as the starting material was obtained as follows:

15 a) 3-chloro-4-fluoro-*N*-{5-[(7-hydroxy-6-methoxyquinazolin-4-yl)amino]pyrimidin-2-yl}benzamide (3.50 g, 6.31 mmol), ethyl 2-(bromomethyl)cyclopropanecarboxylate (1.55 g, 7.49 mmol, see-patent WO 9204339) and potassium carbonate (4.12 g, 33.55 mmol) were combined in dimethylacetamide and heated to 60 °C for 18 hours. The reaction mixture was poured into water (400 ml) and the resultant precipitate filtered, dried and washed with diethyl  
20 ether to afford ethyl 2-({[4-({2-[(3-chloro-4-fluorobenzoyl)amino]pyrimidin-5-yl)amino)-6-methoxyquinazolin-7-yl]oxy)methyl)cyclopropanecarboxylate as a beige solid (2.75 g, 77 % yield) :

MS (+ve ESI): 565 (M+H)<sup>+</sup>.

b) A solution of lithium aluminium hydride (5.5 ml, 1M solution in tetrahydrofuran) in  
25 tetrahydrofuran (60 ml) was cooled to 0 °C and a solution of ethyl 2-({[4-({2-[(3-chloro-4-fluorobenzoyl)amino]pyrimidin-5-yl)amino)-6-methoxyquinazolin-7-yl]oxy)methyl)cyclopropanecarboxylate (1.56 g, 2.75 mmol) in tetrahydrofuran (20 ml) was added slowly. The solution was stirred at 0 °C for 3 hours and further portions of lithium aluminium hydride (3 x 2.75 ml) were added at 0 °C at 18, 28 and 36 hours with warming to  
30 ambient temperature between each addition. The reaction mixture was cooled to 0 °C and hydrochloric acid (15 ml, 1 N solution in water) added slowly. Water (200 ml) was added and the reaction extracted with ethyl acetate (3 x 200 ml). The organics were combined, dried (magnesium sulphate) and concentrated (< 20 °C ) to afford a yellow solid. Trituration with

diethyl ether afforded 3-chloro-4-fluoro-*N*-{5-[(7-{[2-(hydroxymethyl)cyclopropyl]methoxy}-6-methoxyquinazolin-4-yl)amino]pyrimidin-2-yl}benzamide as a yellow solid (726 mg, 50 % yield) :

<sup>1</sup>H-NMR (DMSO-*d*<sub>6</sub>): 9.80 (s, 1H), 9.20 (s, 2H), 8.50 (s, 1H), 8.20 (d, 1H), 8.05 (m, 2H),  
 5 7.81 (s, 1H), 7.65 (t, 1H), 7.25 (s, 1H), 4.50 (t, 1H), 4.20-3.80 (m, 2H), 3.40-3.20 (m, 2H),  
 1.40-1.00 (m, 2H), 0.61 (m 2H) :

MS (+ve ESI): 525 (M+H)<sup>+</sup>.

**Example 22-Preparation of Compound 22 in Table 3 - 2-[4-({[4-({2-[3-chloro-4-fluorobenzoyl]amino]pyrimidin-5-yl}amino)-6-methoxyquinazolin-7-yl]oxy}methyl)piperidin-1-yl]ethyl dihydrogen phosphate**

A solution of 3-chloro-4-fluoro-*N*-{5-[(7-{[1-(2-hydroxyethyl)piperidin-4-yl]methoxy}-6-methoxyquinazolin-4-yl)amino]pyrimidin-2-yl}benzamide (79 mg, 0.13 mmol) in dimethylformamide (2 ml) was reacted with 1-*H* tetrazole (41 mg, 0.58 mmol) and  
 15 dibenzyl diethylphosphoramidite (60 µl, 0.20 mmol) and stirred at ambient temperature for 18 hours. Further portions of dibenzyl diethylphosphoramidite (100 µl) were added after 2 hours and 5 hours. The reaction mixture was cooled to -50 °C and 3-chloroperoxybenzoic acid (81 mg, 0.46 mmol) was added and the reaction mixture warmed to 0 °C. A further portion of 3-chloroperoxybenzoic acid (60 mg) was added at -50 °C and the solution was stirred for 4  
 20 hours then cooled to 0 °C. A solution of sodium metabisulphite (0.53 N aqueous solution) was added and the reaction was warmed to ambient temperature over 15 minutes then extracted with dichloromethane. The combined organic layers were dried (magnesium sulphate), filtered and concentrated under reduced pressure to yield the crude phosphate ester as a viscous, yellow oil. Purification by flash chromatography on silica gel, eluting with  
 25 dichloromethane : methanol : 7.0 N ammonia in methanol (9:1:0 to 9:1:0.8) yielded dibenzyl 2-[4-({[4-({2-[3-chloro-4-fluorobenzoyl]amino]pyrimidin-5-yl}amino)-6-methoxyquinazolin-7-yl]oxy}methyl)piperidin-1-yl]ethyl phosphate as a yellow oil (41 mg, 46 % yield) :

MS (+ve ESI): 842 (M+H)<sup>+</sup>.

30 Dibenzyl 2-[4-({[4-({2-[3-chloro-4-fluorobenzoyl]amino]pyrimidin-5-yl}amino)-6-methoxyquinazolin-7-yl]oxy}methyl)piperidin-1-yl]ethyl phosphate (41 mg, 0.048 mmol) was dissolved in dichloromethane and cooled to -78 °C. Bromotrimethylsilane (70 µl, 0.05 mmol) was added and the solution allowed to warm to ambient temperature and stirred for 1

hour. Methanol (3 ml) was added and the reaction concentrated, redissolved in methanol and evaporated to dryness. The residue was triturated with diethyl ether and filtered under nitrogen to yield the title compound as a yellow hydrobromide salt (41 mg, 98 % yield) :

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 9.20 (s, 2H), 8.80 (s, 1H), 8.55 (s, 1H), 8.25 (s, 1H), 8.20 (m, 1H), 8.05 (m, 1H), 7.51 (t, 1H), 7.41 (s, 1H), 4.30 (m, 2H), 4.20 (m, 2H), 4.05 (s, 3H), 3.60 (m, 2H), 3.41 (t, 2H), 3.20 (t, 2H), 2.35 (m, 1H), 2.25 (m, 2H), 1.90-1.70 (m, 2H) :

MS (-ve ESI): 660 (M-H)<sup>-</sup>.

3-chloro-4-fluoro-*N*-{5-[(7-{[1-(2-hydroxyethyl)piperidin-4-yl]methoxy}-6-methoxyquinazolin-4-yl)amino]pyrimidin-2-yl}benzamide used as the starting material was  
10 obtained as follows:

a) 3-chloro-4-fluoro-*N*-{5-[(7-hydroxy-6-methoxyquinazolin-4-yl)amino]pyrimidin-2-yl}benzamide (3.85 g, 6.94 mmol), *tert*-butyl 4-({[(4-methylphenyl)sulfonyl]oxy)methyl}piperidine-1-carboxylate (3.16 g, 8.55 mmol see-patent WO 0200649) and potassium carbonate (4.2 g, 30.4 mmol) were dissolved in  
15 dimethylacetamide (50 ml) and stirred at 60 °C for 18 hours. The reaction mixture was cooled, poured into water (100 ml) and the resultant precipitate isolated. This was dissolved in a mixture of dichloromethane : trifluoroacetic acid (2:1, 30 ml) and stirred at ambient temperature for 5 hours. The reaction mixture was concentrated, toluene added and re-concentrated. The resultant solid was triturated with ether, filtered and dried to yield 3-chloro-  
20 4-fluoro-*N*-(5-{[6-methoxy-7-(piperidin-4-ylmethoxy)quinazolin-4-yl]amino}pyrimidin-2-yl)benzamide di-trifluoroacetate as a beige solid (4.6 g, 86 % yield) :  
MS (+ve ESI): 538 (M+H)<sup>+</sup>.

b) 3-chloro-4-fluoro-*N*-(5-{[6-methoxy-7-(piperidin-4-ylmethoxy)quinazolin-4-yl]amino}pyrimidin-2-yl)benzamide di-trifluoroacetate (4.6 g, 6.0 mmol), triethylamine (5  
25 ml, 26.6 mmol) and 2-bromoethanol (2.20 ml, 31.0 mmol) were dissolved in dimethylformamide (100 ml) and heated at 60 °C for 18 hours. The reaction mixture was cooled and concentrated. Purification by flash chromatography on silica gel, eluting with dichloromethane : methanol (4:1) followed by increased polarity to dichloromethane :  
30 methanol : ammonia (4:1:0.1) yielded 3-chloro-4-fluoro-*N*-{5-[(7-{[1-(2-hydroxyethyl)piperidin-4-yl]methoxy}-6-methoxyquinazolin-4-yl)amino]pyrimidin-2-yl}benzamide as a beige solid (1.7 g, 48 % yield) :

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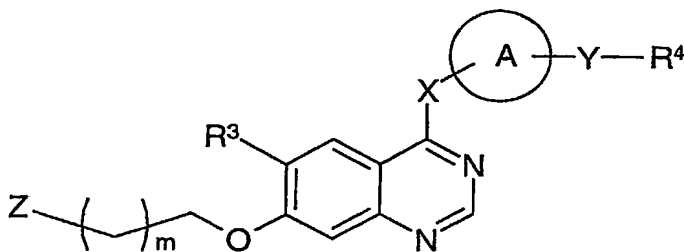
-68-

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): 9.80 (s, 1H), 9.15 (s, 2H), 8.80 (s, 1H), 8.20 (m, 1H), 8.00 (m, 1H), 7.80 (s, 1H), 7.60 (t, 1H), 4.20 (s, 1H), 4.05 (m, 5H), 3.65 (m, 2H), 3.15 (m, 2H), 2.40 (m, 2H), 2.25-2.00 (m, 2H), 1.90-1.70 (m, 3H), 1.55 (m, 2H) :

MS (-ve ESI): 580 (M-H)<sup>-</sup>.

CLAIMS

1. A compound of formula (I):



5

formula (I)

wherein A is 6-membered heteroaryl containing a nitrogen atom and optionally containing one or two further nitrogen atoms;

X is O, S, S(O), S(O)<sub>2</sub> or NR<sup>14</sup>;

10 m is 0, 1, 2, 3 or 4;

Y is O, NR<sup>5</sup>CO, CONR<sup>5</sup>, CR<sup>6</sup>R<sup>7</sup>CONR<sup>5</sup> or CR<sup>6</sup>R<sup>7</sup>NR<sup>5</sup>;

Z is a group selected from -NR<sup>1</sup>R<sup>2</sup>, phosphonooxy, C<sub>3-6</sub>cycloalkyl (substituted by phosphonooxy or C<sub>1-4</sub>alkyl (substituted by phosphonooxy)) and a 4- to 7-membered ring

15 linked via a carbon atom containing a nitrogen atom and optionally containing a further nitrogen atom, which ring may be saturated, partially saturated or unsaturated wherein the ring is substituted on carbon or nitrogen by phosphonooxy or C<sub>1-4</sub>alkyl (substituted by phosphonooxy) and wherein the ring is optionally further substituted on carbon or nitrogen by 1, 2 or 3 halo or C<sub>1-4</sub>alkyl groups;

20 R<sup>1</sup> is -COR<sup>8</sup>, -CONR<sup>8</sup>R<sup>9</sup> or C<sub>1-6</sub>alkyl (substituted by phosphonooxy and optionally further substituted by 1 or 2 halo or methoxy groups);

R<sup>2</sup> is hydrogen, -COR<sup>10</sup>, -CONR<sup>10</sup>R<sup>11</sup>, C<sub>1-6</sub>alkyl (optionally substituted by 1, 2 or 3 halo or C<sub>1-4</sub>alkoxy groups or -S(O)<sub>p</sub>R<sup>11</sup> (where p is 0, 1 or 2) or phosphonooxy), C<sub>2-6</sub>alkenyl, C<sub>2-6</sub>alkynyl, C<sub>3-6</sub>cycloalkyl and C<sub>3-6</sub>cycloalkylC<sub>1-4</sub>alkyl;

25 or R<sup>1</sup> and R<sup>2</sup> together with the nitrogen to which they are attached form a 4- to 7- membered ring optionally containing a further nitrogen atom which may be saturated, partially saturated or unsaturated wherein the ring is substituted on carbon or nitrogen by a group selected from phosphonooxy and C<sub>1-4</sub>alkyl (substituted by phosphonooxy or -NR<sup>8</sup>R<sup>9</sup>) and where the ring is optionally further substituted on carbon or nitrogen by 1, 2 or 3 halo or C<sub>1-4</sub>alkyl groups;

$R^3$  is hydrogen, halo, cyano, nitro,  $C_{1-6}$ alkoxy,  $C_{1-6}$ alkyl,  $-OR^{12}$ ,  $-CHR^{12}R^{13}$ ,  $-OC(O)R^{12}$ ,  $-C(O)R^{12}$ ,  $-NR^{12}C(O)R^{13}$ ,  $-C(O)NR^{12}R^{13}$ ,  $-NR^{12}SO_2R^{13}$  or  $-NR^{12}R^{13}$ ;

$R^4$  is hydrogen or a group selected from  $C_{1-4}$ alkyl, heteroaryl, heteroaryl $C_{1-4}$ alkyl, aryl and aryl $C_{1-4}$ alkyl where the group is optionally substituted by 1, 2 or 3 substituents selected from

5 halo, methyl, ethyl, cyclopropyl and ethynyl;

$R^5$  is selected from hydrogen,  $C_{1-4}$ alkyl,  $C_{2-4}$ alkenyl,  $C_{2-4}$ alkynyl,  $C_{3-6}$ cycloalkyl and  $C_{3-6}$ cycloalkyl $C_{1-4}$ alkyl;

$R^6$  and  $R^7$  are independently hydrogen, halo,  $C_{1-4}$ alkyl,  $C_{3-6}$ cycloalkyl, hydroxy and  $C_{1-4}$ alkoxy;

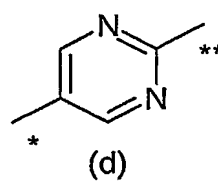
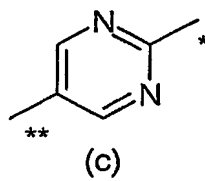
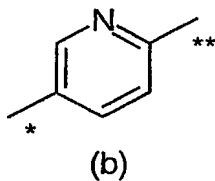
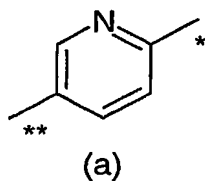
10  $R^8$  is  $C_{1-4}$ alkyl substituted by phosphonooxy and optionally further substituted by 1 or 2 halo or methoxy groups;

$R^9$  is hydrogen or  $C_{1-4}$ alkyl;

$R^{10}$  is hydrogen or  $C_{1-4}$ alkyl (optionally substituted by halo,  $C_{1-4}$ alkoxy,  $S(O)_q$  (where  $q$  is 0, 1 or 2) or phosphonooxy);

15  $R^{11}$ ,  $R^{12}$ ,  $R^{13}$  and  $R^{14}$  are independently hydrogen,  $C_{1-4}$ alkyl or heterocyclyl; or a pharmaceutically acceptable salt thereof.

2. A compound according to claim 1 wherein A is a group of formula (a), (b), (c) or (d):



20 where \* is the point of attachment to the X group of formula (I) and \*\* is the point of attachment to the Y group of formula (I).

3. A compound according to claim 2 wherein A is a group of formula (b) or (d) as defined in claim 2.

25

4. A compounds according to any one of claims 1, 2 or 3 wherein X is NH.

5. A compound according to any one of the preceding claims wherein Z is  $-NR^1R^2$ , phosphonooxy, cyclopropyl (substituted by  $C_{1-4}$ alkyl (substituted by phosphonooxy)) and

30 piperidine or piperazine ring linked via a coarbon atom where the ring is substituted on carbon or nitrogen by phosphonooxy or  $C_{1-4}$ alkyl (substituted by phosphonooxy).



6. A pharmaceutical composition comprising a compound according to any one of the preceding claims in association with a pharmaceutically acceptable diluent or carrier.

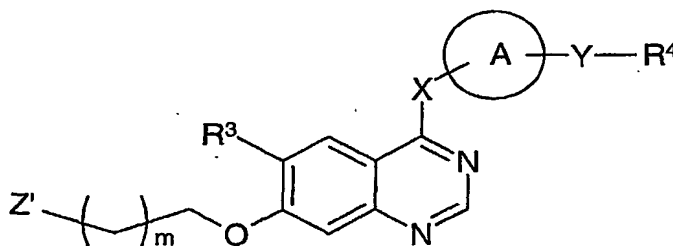
5 7. Use of a compound according to any one of claims 1 to 5 in therapy.

8. Use of a compound according to any one of claims 1 to 5 in the preparation of a medicament for the treatment of a disease where the inhibition of one or more Aurora kinase is beneficial.

10

9. Use according to claim 8 wherein Aurora kinase is Aurora-A kinase or Aurora-B kinase.

10. A process for the preparation of a compound according claim 1 comprising converting  
15 a compound of formula (II) into a compound of formula (I) by phosphorylation of an appropriate hydroxy group:



formula (II)

where A, X, m, Y, R<sup>2</sup>, R<sup>3</sup> and R<sup>4</sup> are as defined in claim 1;

20 Z' is a group selected from -NR<sup>1'</sup>R<sup>2</sup>, hydroxy, C<sub>3-6</sub>cycloalkyl (substituted by hydroxy or C<sub>1-4</sub>alkyl (substituted by hydroxy)) and a 4- to 7-membered ring linked via a carbon atom, containing a nitrogen atom and optionally containing a further nitrogen atom, which ring may be saturated, partially saturated or unsaturated wherein the ring is substituted on carbon or nitrogen by hydroxy or C<sub>1-4</sub>alkyl (substituted by hydroxy) and wherein the ring is optionally  
25 further substituted on carbon or nitrogen by 1, 2 or 3 halo or C<sub>1-4</sub>alkyl groups;  
R<sup>1'</sup> is -COR<sup>8'</sup>, -CONR<sup>8'</sup>R<sup>9'</sup> or C<sub>1-6</sub>alkyl (substituted by hydroxy and optionally further substituted by 1 or 2 halo or methoxy groups); or R<sup>1'</sup> and R<sup>2</sup> together with the nitrogen to which they are attached form a 4- to 7- membered ring optionally containing a further

nitrogen atom which may be saturated, partially saturated or unsaturated wherein the ring is substituted on carbon or nitrogen by a group selected from hydroxy and C<sub>1-4</sub>alkyl (substituted by hydroxy or -NR<sup>8'</sup>R<sup>9</sup>) and where the ring is optionally further substituted on carbon or nitrogen by 1, 2 or 3 halo or C<sub>1-4</sub>alkyl groups; and

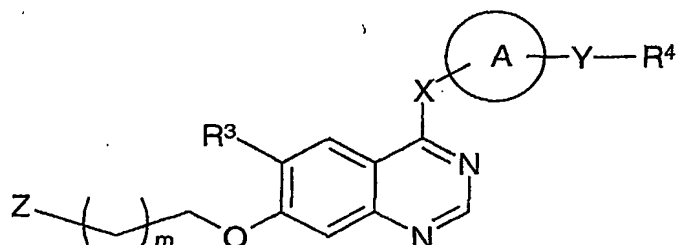
- 5 R<sup>8'</sup> is C<sub>1-4</sub>alkyl substituted by hydroxy and optionally further substituted by 1 or 2 halo or methoxy groups:

and thereafter if necessary:

- i) converting a compound of the formula (I) into another compound of the formula (I);
  - ii) removing any protecting groups;
- 10 iii) forming a pharmaceutically acceptable salt.

ABSTRACT

Quinazoline derivatives of formula (I):



- 5 wherein A is 6-membered heteroaryl containing a nitrogen atom and optionally containing one or two further nitrogen atoms; compositions containing them, processes for their preparation and their use in therapy.



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PCT Application  
**GB0305640**



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